TECHNOLOGY DEPT.

Power Plant ENGINEERING

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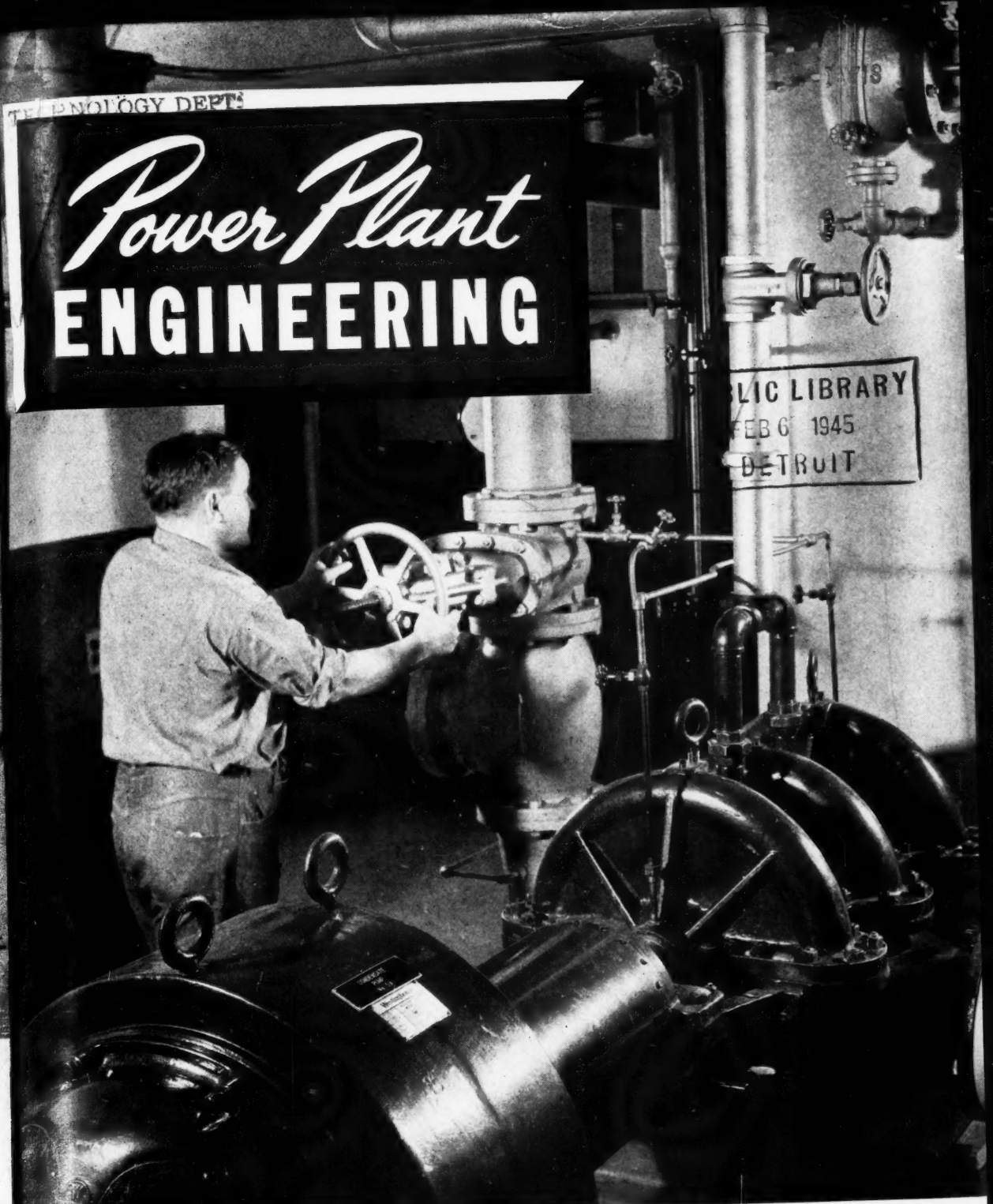
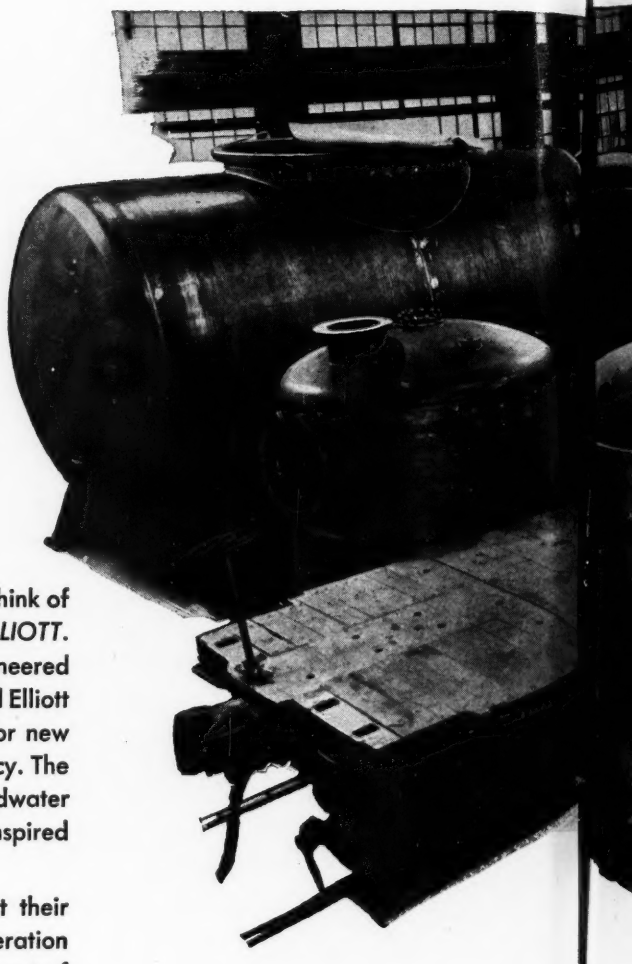


THE POWER ENGINEERING AND MAINTENANCE MAGAZINE FOR EVERY INDUSTRY

Features

Deaeration for the seven



This group of Elliott deaerating feedwater heaters will have a varied and interesting career. Some of them are destined for aircraft carriers. Others for troop transports, for destroyers, for Victory ships. And in the background, two vertical deaerating heaters with horizontal storage tanks, for important public utility plants making power for the home front.

AFLOAT OR ASHORE, when engineers think of *deaeration* they generally think of *ELLIOTT*. For the deaeration principle was first pioneered by Elliott engineers, striking out with typical Elliott enterprise into untrodden fields, aiming for new goals of steam plant economy and efficiency. The successful combining of deaeration and feedwater heating in a single unit is the result of this inspired effort.

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Your deaeration problem may be simple or complicated. In either case you can with advantage discuss it with Elliott engineers.

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nseas-*and for the home front too.*

N-981

OTT pioneered deaeration
–and is still ahead!

POWER

Official U. S. Navy Photograph

BRISTLING with 149 destruction-dealing guns — from giant 16-inch rifles to 20-mm. anti-aircraft batteries — the 45,000-ton battleship Iowa symbolizes the growing might and power of the U. S. Navy. Four sets of geared turbo-electric drives speed the Iowa along at better than 30 knots, making her the fastest as well as the deadliest dreadnought afloat.

In every type of installation — large or small, on land or sea—where turbines are used to generate electrical power, they operate more efficiently, give more dependable service when lubricated effectively. That is why more and more engineers — in hydro and steam plants — use Texaco.

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Power Plant ENGINEERING

February 1945

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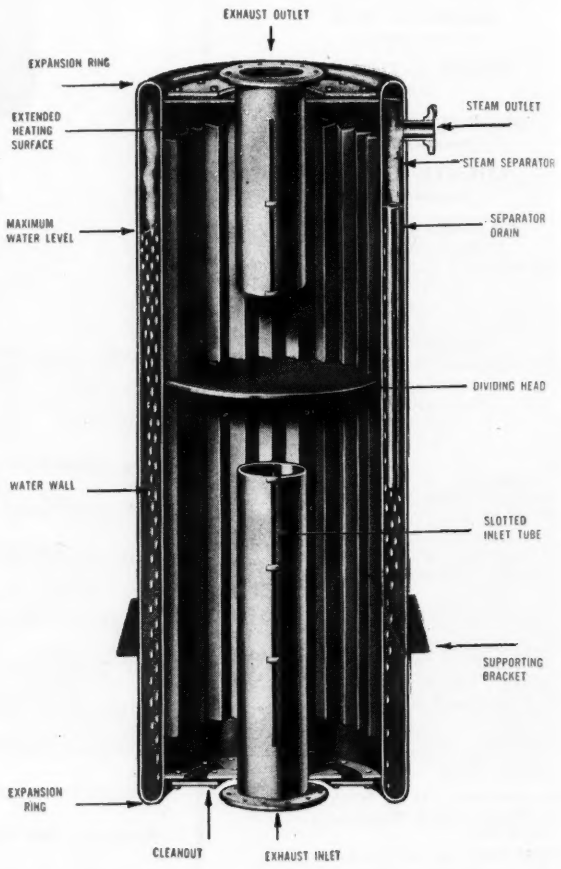
HOW TO PUT WASTE HEAT TO WORK

WITH MAXIM HEAT RECOVERY SILENCERS

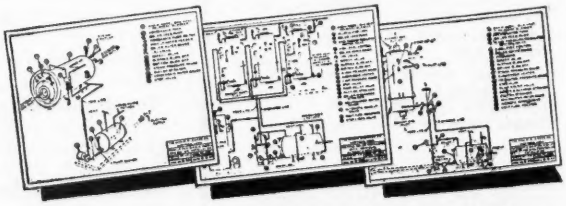
Engine exhaust heat, all too often wasted, can be put to good and profitable use through Maxim Heat Recovery Silencers. With these specially constructed silencers extra steam or hot water for heating or processing operations is obtained *without extra fuel cost* as the heat source is simply engine exhaust heat. Thus in one unit effective exhaust silencing, spark arresting (where necessary) and heat recovery are combined for maximum operating efficiency. Such a saving, important to your balance sheet at any time, is doubly important where fuel supplies are difficult to obtain.

The power plant below located in northern Minnesota is heated entirely through the use of Maxim Heat Recovery Silencers.

For silencing, without the heat recovery feature, Maxim makes silencers for internal combustion engine exhaust or intake, steam engine exhaust, air compressor intake, vacuum pump discharge, blower intake and discharge, high velocity steam, air or gas discharge. Engine exhaust silencers available with or without spark arrestor. Bulletins on request.



PRACTICAL WORKING HOOK-UPS



The Maxim Engineering Department has prepared several drawings of typical Heat Recovery Silencer hook-ups. These are available with a detailed discussion of each hook-up. We will be glad to send them to you. Just ask for Dwgs. B-298, B-301, B-302 and B-303.

ARMY E NAVY

MAXIM

THE MAXIM SILENCER CO. • 89 HOMESTEAD AVE., HARTFORD, CONN.

Front Lines

THE FIELD OF ADHESIVES during the war holds promise of postwar growth for the industry, according to Fred Wehmer of Minnesota Mining & Manufacturing Co. at the annual meeting of the ASME. Structural adhesives may vary from the vulcanizing adhesives used to fasten rubber and synthetic rubbers to metals, to adhesives for plywood and adhesives for lamination of metal parts. Another type of material which has unique properties is that made from latex or water dispersed resins. Included in this group are the water dispersed reclaims and the glues and starches. They offer the advantage of a non-toxic solvent along with the fact that there is no fire hazard connected with the usage of this type of material. Materials of this type find a large usage in combining paper and cloth, and crude and synthetic rubber latex give unique films in that they are flexible over a wide range and possess quite a bit of elongation. Adhesives are also finding use in the application of coatings for the lining of chemical equipment. Through the use of adhesives in combination with compounds designed for application over these adhesives, it is now possible to line tanks in the field.

OPERATION OF THE ROTOR on a helicopter by means of a jet of air in the same manner that a stream of water turns the conventional lawn sprinkler was described by Donnell W. Dutton, director of the Daniel Guggenheim School of Aeronautics, Georgia School of Technology, Atlanta, Ga., at the annual ASME meeting. Describing the development of helicopters from the time of the first sketch of such a machine credited to Leonardo da Vinci in 1519, the speaker turned to the experiments under way at the Guggenheim School. "A jet of air, instead of water, of course, is discharged at the tip of the rotor to drive it around. Since there is no mechanical connection between the rotor blade and the fuselage, there is no torque reaction to overcome. At present, the air is drawn in the nose of the ship through a duct system by a high speed axial blower, and out through the hub and into the hollow blade. We know that this machine, or a machine of this type, can be made to lift itself off the ground. It now remains to improve the efficiency of its drive to the point where it can compete with a pure mechanical drive. It has been suggested that the air or gases should be ejected all along the blade instead of just at the tip, and so effect boundary layer control. Professor Starker, formerly at the University of Michigan, was experimenting with this type of jet propulsion. Placing motors and propellers on the rotor blades to pull them forward without producing any torque reaction has been tried, but without a great deal of success."

TWO YEARS of successful experience with high-temperature turbine generators (950 F) such as the 125,000-kw three-cylinder unit built by Westinghouse for the Burlington Generating Station of Public Service Electric and Gas Co. of New Jersey makes designers willing to take the next step—1000 F. The experience with the 50,000-kw 1600-psi, 950 F superposed unit at Sherman Creek Station of Consolidated Edison Co. of New York has been equally gratifying. A 50-degree rise in temperature of inlet steam means a gain of nearly two per cent in overall plant efficiency.

POSSIBILITY of the not-so-distant future development of a fuel-injection two-cycle engine rivalling the Diesel in power and economy, and satisfactory for tractor use, was suggested recently at SAE National Tractor Meeting. Fuel injection, according to H. O. Hill, of American Bosch Corp., Springfield, Mass., may restore the two-stroke-cycle engine to favor by correcting its wastefulness of fuel, relative inefficiency at fractional loads and speeds, and poor idling qualities. Mr. Hill added that four-cycle engines, if designed for the purpose, also might benefit from the inherent advantages of fuel injection, among which he listed fuel economy, higher power output, increase in volumetric efficiency at speed, better low-speed torque characteristics, excellent cold-starting qualities, and proper functioning on low-grade fuels. Gasoline injection equipment can be applied to carburetor-equipped engines, he said, with some, if not full, advantage. Mr. Hill warned that fuel injection systems have certain disadvantages, such as higher cost, deterioration in storage, extreme sensitivity to foreign matter in fuel, and, in the case of tractors, higher costs resulting from necessity for using gasoline.

THE G. I. BILL OF RIGHTS may lead to an academic double standard with war veterans suffering from the lowest standards, warns Dr. Robert M. Hutchins, president of the University of Chicago. "The danger is," he says, "that the already large number of uneducated technicians in the country will be increased by the bill. The overwhelming majority of veterans will be interested in vocational education and, because the oversupply of technicians is certain to be great, disappointment awaits those who, for educational reason, pursue a technical education. What this country needs is a good liberal education. And then it needs to have everybody have it." Dr. Hutchins points out that one great benefit of the G. I. bill is that a veteran will be able to go as far educationally as his capacities will take him without being limited by capacity to pay. But he also points out that the colleges, their programs and faculties wrecked by the war, are unprepared for the post-war burden. They will be greatly tempted, for financial reasons, to give the veterans what they think they want, thinks Dr. Hutchins, rather than what they should have for their own good and the good of the country. For years we have believed that what engineers need most is more liberal education, not less. That they need more engineering education is a truism but, as a general thing, they can get that if they really want to do the work necessary. But that is a much different thing from the technical training given for military purposes. Moreover, badly organized and hastily contrived though the ASTP may have been, it did recognize fully the need for the proper balance between liberal and technical studies. Its real defect was merely that those things can't be done in 13 weeks. Engineers are not made in a year of technical training. Only those who reach the top of the profession realize that Whitman *may* be as important as Stodola, that Ravel or Brahms *may* have as much to do with success in engineering as Keenan and Keyes.

TYRANNY of the unknown, illiteracy, premature senility and the threat of the deadening uniformity of culture are the four major enemies of mankind against which relentless war must be waged in the post-war era with the same determination with which we are now fighting on the battlefields. That is the opinion of Dr. Harlow Shapley, director of the Harvard Observatory, expressed before a recent meeting of the American Association for the Advancement of Science, as reported by the Boston Herald. "We ought to declare a systematic national war immediately on at least five major groups of maladies that prematurely age and kill our citizens," he said. "These are cancer, mental disease, arthritis, and the diseases of the circulatory and respiratory systems." Dr. Shapley insists we should take an attitude of good cosmic sportsmanship that aspires us to go to the top, to the limit of our abilities and aspirations; for, who knows, there may be something in that rainbow's end that will make even the galaxies look incidental. "Whatever the postulates in which we clothe ourselves, whether our tailors are religious prophets, pagan philosophers, modern scientific cosmogonists or the still-striving spirit of jungle-born curiosity, the majority of Americans are already amply dressed for the up-hill climb. I may be obsessed, or suffering from authropocentric illusions, but I cannot escape the feeling that the human mind and human curiosity are significant in this world, perhaps even in the cosmos of geological time and intergalactic space."

RECONVERSION OF OUR THINKING is probably the most important phase of this country's reconversion problem. Physical reconversion will involve: the time required to get materials; the time required to re-arrange production facilities; the time required to train personnel; and the time necessary to build production up to the capacity for which the facilities were built. Analyzing this physical part of the problem before the Southeastern Electric Exchange, J. H. Ashbaugh, Westinghouse vice-president, said he believed it would require three months for either obtaining material or for factory re-arrangement, one month for fabricating of parts—and production in the fifth month. Then he turned to the reconversion of our minds and our approach to post-war problems. The problems of management will change with reconversion from a situation in which speed in production for only one customer, the United States Government, was vital, to a situation in which the commercial phases of business, to obtain the load our plants require, will be paramount. Engineering departments must design for civilian rather than military demands. Production departments must produce them properly. But it will be the sales or commercial department's job to dig up the customers and sell the products to them. The customer is not much interested in how the manufacturer solves his problems, says Mr. Ashbaugh. But the customer must be shown by the sales department why he should buy any one particular company's products. For despite our accumulated deferred demands, our 100 billion dollars of savings, our experience of being unable during the war to buy the things we wanted, Mr. Ashbaugh does not believe people are going to rush madly into buying everything everybody can produce. Despite the tremendous stored-up purchasing power, there is only so much of it after all. If it goes into a new car or a new refrigerator or an electrical appliance, it cannot go into something else. The same thing is true of business purchases. Hence our business thinking in the future must be reconverted to the selling attitude. This will call for a rehabilitation of our sales organizations and selling methods and it is none too early to be planning this mental reconversion now.

DEPARTMENT OF LIBERAL EDUCATION in the House Organs in 15 Minutes a Day:—Lubrication of Portable Air Tools, including detailed cross-sections and phantom views of many of the common tools; Lubrication, November, 1944; The Texas Co. * * * Clear Signs for Victory, how laminates are used for signs and instrument panels; Bakelite Review, November, 1944; Bakelite Corp. * * * Gilding the Plastics Lily; also six pages of shrewd, good-humored comment by a smooth-writing editor—and you'll get a kick out of the picture of the two sailors and the two girls sitting in the railroad waiting room; The Blue Knight, November, 1944; Roxalin Flexible Finishes, Inc. * * * Description of a closed Diesel engine jacket system; The Betz Indicator, December, 1944; W. H. & L. D. Betz * * * Evaporative Coolers for Diesel Engines; Weather Magic, November, 1944; The Trane Co. * * * Control That Speed, detailed discussion of large adjustable speed motor drives; Gas Turbine—Ready for Rails, detailed description by J. T. Retalliata of a new gas turbine locomotive design; Fundamental Problems of A-C Circuit Interruption, detailed discussion with solutions; many splendid photographs of equipment; Electrical Review, December, 1944; Allis-Chalmers Mfg. Co. * * * The Weasel, a new and radical vehicle of war produced by Studebaker; The Power Specialist, Fall, 1944; Johns-Manville * * * Wizards Without Wands, how state engineers restore historical buildings and structures, with interesting illustrations; Illinois Public Works, Fall, 1944; Dept. of Public Works & Buildings, Springfield, Ill. * * * First Aid for the Maintenance Welder; the Eutectic Welder, December, 1944; Eutectic Welding Alloys, Inc. * * * The Sage of Monticello, interesting illustrated biography of Thomas Jefferson; Mileposts in Stoker Development; The Fusion Point, November, 1944; Southern Coal Co., Inc. * * * Salute to Railroads and Salute to Steel; illustrated descriptions of the two industries; Valve World, November and December, 1944; Crane Co. * * * Traps Save Laundry 2 Hours Heating-Up Time and 10% Fuel; Armstrong Trap Magazine, No. 4, 1944; Armstrong Machine Works * * * Birthplace of Air Power, detailed description of Wright Field, with some unusual photographs; Around the Clock with U. S. Time, in an unusual old Connecticut clock shop; Shell Progress, November-December, 1944; Shell Oil Co. * * * Henry Ford Rebuilds Station A, the first power house of the Edison Electric Illuminating Co., Synchroscope, January, 1945; Detroit Edison Co. * * * Slips That Pass in the Mike, all about announcers' and speakers' horrible "fluffs" on the radio; It's Hard as A-B-C, all about flag signals, with the flags in colors, Ethyl News, January, 1945; Ethyl Corp.

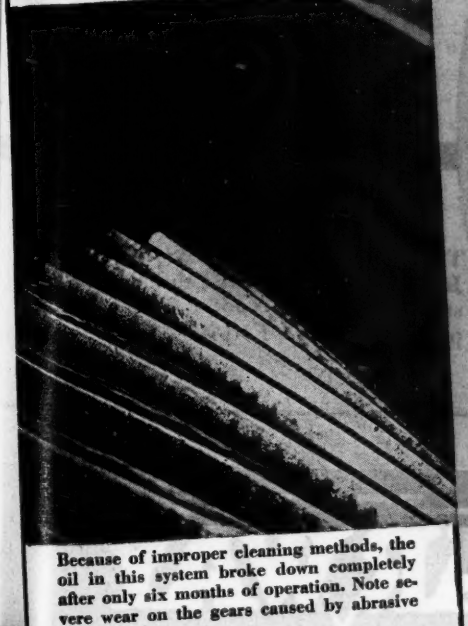
A GOOGOL? What? You never saw one? Well, for a portrait of one, look in the Comptometer ad on page 62 of the December 23, 1944, issue of Collier's. It's a fearsome thing (the googol, we mean, not Collier's). The name, we are told, is given to a number consisting of 1 followed by 100 zeros. Mathematicians, however, are not scared by googols. They just whittle 'em down to size by writing 10^{100}. We never could understand why people are afraid of big numbers. Why try to visualize them? Write 'em as the mathematickers do: X times 10 to the umpteenth power. Incidentally, we are told that a googol must be a very big number because all the raindrops falling on Chicago in a century are less than a googol. Who counted 'em? Bet all the snow flakes that have fallen on Chicago since December 15, 1944, are more than several googols. Must be the goo from these googols that we've been wading around in ever since that time.

Don't send good turbine oil after bad-

CLEAN DIRTY OIL SYSTEMS!

HERE'S WHAT HAPPENS TO TURBINE GEARS WHEN SYSTEM IS NOT PROPERLY CLEANED

Scoring of the gears, above, was caused by metal chips left by insufficient cleaning at the time of initial installation.



Because of improper cleaning methods, the oil in this system broke down completely after only six months of operation. Note severe wear on the gears caused by abrasive contaminants.

The New SHELL CLEANING PROCEDURE makes it easy... more efficient

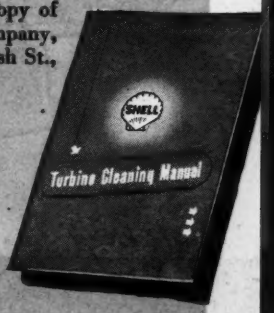
IT HAS BEEN PROVED that the presence of a small amount of used turbine oil in a new fill may reduce the life of the new charge by as much as 50%! In addition, contaminants can cause excessive wear, improper operation of the governor, affect seriously the flow of oil to vital parts, interfere with the efficient transfer of heat in bearings and oil coolers.

Not only should *dirty* oil systems be cleaned, but the cleaning of *new* equipment is also necessary. In a new turbine, materials such as loose mill scale, metal chips, core sand, gasket compound, slushing compound, run-in oil and any rust that may have formed during the erection of the turbine, must be removed. They *can* be removed, and effectively, by new, Shell Turbo Cleaner, using Shell's Turbine Cleaning Procedure.

Before you add that next batch of oil to your system, be sure to get the details on Shell Turbo Cleaner and Shell's Cleaning Procedure. See your Shell man or send for your copy of the Turbine Cleaning Manual. Address: Shell Oil Company, Inc., 50 W. 50th St., New York 20, N. Y., or 100 Bush St., San Francisco 6, Calif.

SHELL

SEND FOR THIS BOOKLET NOW! Every turbine owner and operator should have a copy. It contains full details on the new Shell Turbo Cleaner and the Shell Turbine Cleaning Procedure. Shows you how simple and easy it is to keep your turbines clean... operating at peak efficiency.



SHELL TURBO OIL

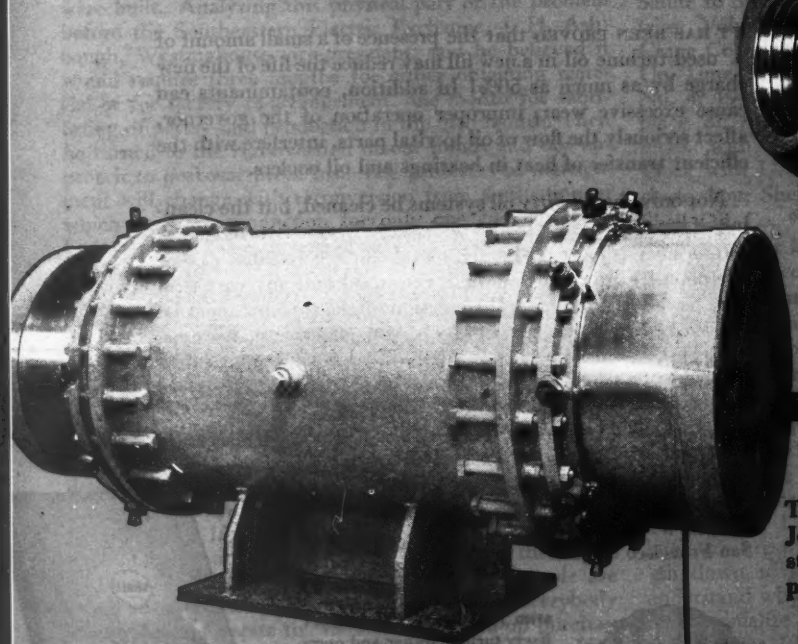
THERE'S

"IMPULSE"

The Yarway Impulse Steam Trap has only one moving part; no buckets, bellows, levers or floats. Bulletin T-1739.

"INVOLUTE"

The Yarway Involute Spray Nozzle is non-clogging, trouble-free. No internal parts; contour of body guides flow in an involute path. For cooling condenser water and for air conditioning service. Bulletin N-616.



"GUN-PAKT"

The Yarway Gun-Pakt Expansion Joint may be re-packed under full steam pressure and never needs unpacking. Bulletin EJ-1909.

YARWAY

A Reason..

ALL these Yarway Steam Specialties have become outstanding successes because of unique Yarway engineering principles. That's why so many plant operators say, "Yarway is our way" when selecting such equipment.

YARNALL-WARING COMPANY
114 Mermaid Ave. Phila. 18, Pa.

"FLOATLESS"

The Yarway Floatless Water Column operates with balanced solid weights, on the well-known displacement principle. Bulletin WG-1809.

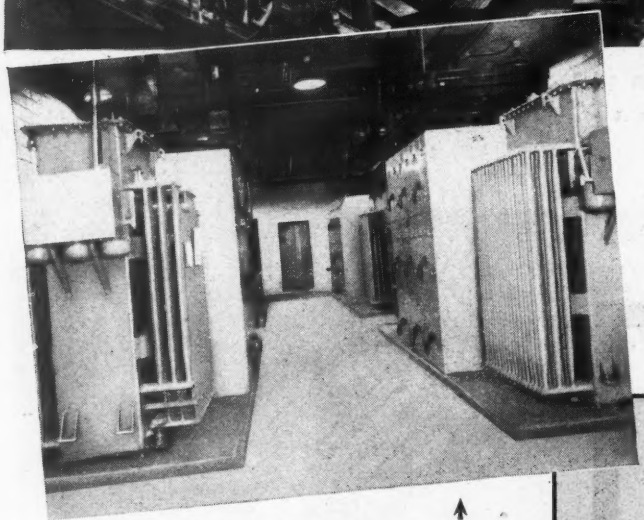
"SEATLESS"

The Yarway Seatless Blow-Off Valve has no seat to score, wear and clog with mud, scale and dirt. Write for Catalog Section B-424 for pressures to 400 lb, Section B-431 for pressures from 400 to 2500 lb.

STEAM SPECIALTIES

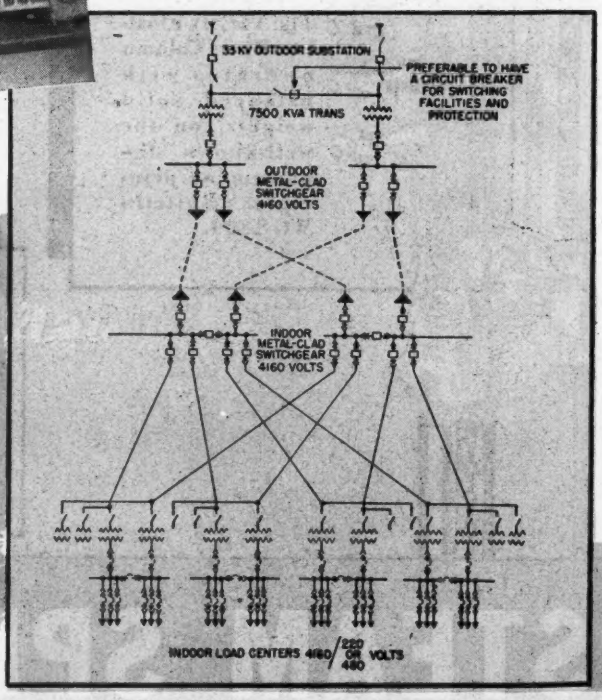
NO "FREEZE" ON

Over the vast floor area of this windowless plant, power taps are close at hand for machines and lighting panels. Metal-enclosed bus runs come up from unit substations directly below in the basement.



A group of G-E load-center unit substations, showing high-voltage lines entering in interlocked-armor cable and the outgoing low-voltage metal-enclosed bus runs. Each load-center unit has two incoming lines.

"One-line diagram" of part of the power distribution circuit, showing the secondary-selective arrangement. Interconnection through sectionalizing breakers in the secondary provides an alternate supply in case of interruption in primary feeder or secondary transformer.


33 KV OUTDOOR SUBSTATION
PREFERABLE TO HAVE A CIRCUIT BREAKER FOR SWITCHING FACILITIES AND PROTECTION
7500 KVA TRANS
OUTDOOR METAL-CLAD SWITCHGEAR 4160 VOLTS
INDOOR METAL-CLAD SWITCHGEAR 4160 VOLTS
INDOOR LOAD CENTERS 4160/220 OR 480 VOLTS

LOAD-CENTER Power Distribution Systems

MACHINE LOCATION

at a plant with a load-center power system

Output has stayed high in this aircraft-engine plant, in spite of work changeovers that require relocation of many machines. In one three-month period, more than 2000 machines were shifted, but these machines never stood idle for lack of electric energy.

Why was full-voltage power so quickly available for every machine, no matter where located? Why has the plant management such complete *freedom* in planning tomorrow's work flow and machine location?

First, because when the plant was built, ***power flow was put on a par with production flow.***

Such advanced features of plant design as windowless, air-conditioned construction could be adopted without misgivings—because the secondary-selective distribution system gives unusual protection to power continuity. It helps make a plant-wide blackout virtually impossible.

Second, because ***the distribution system is of the modern load-center type.***

Individual G-E unit substations are located in the basement, for the most part directly below the load areas they serve. Primary power is distributed to these units at 4160 volts, each load-center substation having two incoming lines. Secondary circuits, each with its individual breaker, consist of short, metal-enclosed bus runs, passing up through the floor and above the work area, with power taps of Flamenol† cable to the machines.

Third, because metal-clad switchgear and unit substations were selected for the job.

A transformer section using Pyranol*, which is non-burning, permits G-E unit substations to be installed without vaults wherever the loads require them. G-E switchgear assures *adequate* interrupting capacity. Increased loads requiring more transformer capacity can be supplied with additional easily installed units.

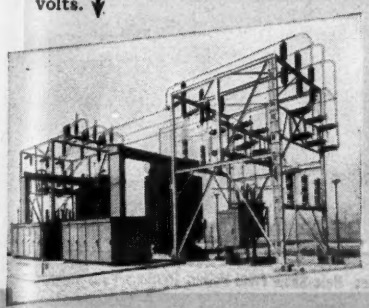
Before you settle on your plans for plant reconversion with respect to power supply, why not review the experience of plants that have adopted *load-center distribution?* G-E application engineers will be glad to give you facts and figures for immediate or postwar consideration. ***General Electric Company, Schenectady 5, N. Y.***

†Reg. U.S. Pat. Off.

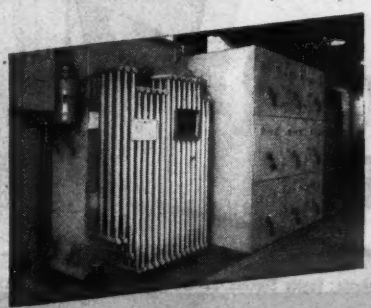
**Trade-mark for General Electric's nonsludging, insulating and cooling liquid that will not burn*

Write for this new booklet—"Load-center Unit Substations" (GEA-3592) gives valuable information on planning a fully modern power system, shows installation in many plants.

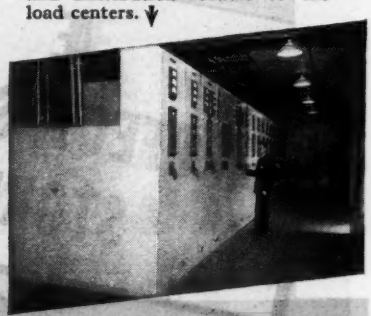
At this outdoor substation, two G-E 7500-kva transformers step down the 33-kv incoming energy to 4160 volts.



Close-up of G-E unit substation showing Pyranol transformer and metal-enclosed, drawout air circuit breakers.



Indoor vertical-lift metal-clad switchgear protects incoming lines and distribution feeders to the load centers.



GENERAL ELECTRIC

What STOKER STREAMLINING MEANS TO YOU

The days when boiler rooms were noisy "black holes" are past, thanks largely to progress in fuel firing equipment like the Æ Perfect Spread Stoker. This modern, completely automatic stoker is not only streamlined in appearance, but "streamlined" in principle, design and operation.

Its compact, fully-protected mechanism runs quietly and steadily, without clogging. It economically burns all kinds and grades of solid fuel, including by-products and refuse . . . with consistently thorough combustion at a low operating cost.

In plants using steam for power, heating or processing, the Æ Perfect Spread Stoker assures important yearly savings. Be sure to *get the facts* that may favorably affect your whole future operation. Write for this new Bulletin, today!

STREAMLINED—UNDER COVER—QUIET!

The all-enclosed, protected mechanism includes automatic, variable-speed feeder with non-clog safety feature and is accessible without tools for inspection or adjustment by merely lifting cover. Simplified construction, water cooling at vital points, and many other features add up to unusually quiet, efficient operation.

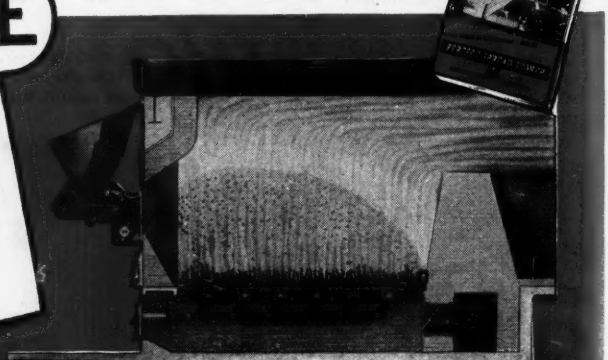
IF YOUR Steam Requirements Call for 175 H. P. up to 200,000 lbs. per hour—

YOU NEED THIS BULLETIN

Write us. 2408 Aramingo Ave., Philadelphia 25, Pa.

Æ

Æ PERFECT SPREAD STOKER



Other Æ Products: Layne Strainers, Le-Bel Meters, Marine Deck Auxiliaries, Rotu-Vane Fuel Pumps, Diamond Face Grinders

AMERICAN ENGINEERING COMPANY

PHILADELPHIA 25, PA.

Copyright 1945, American Engineering Co.

15 MINUTES

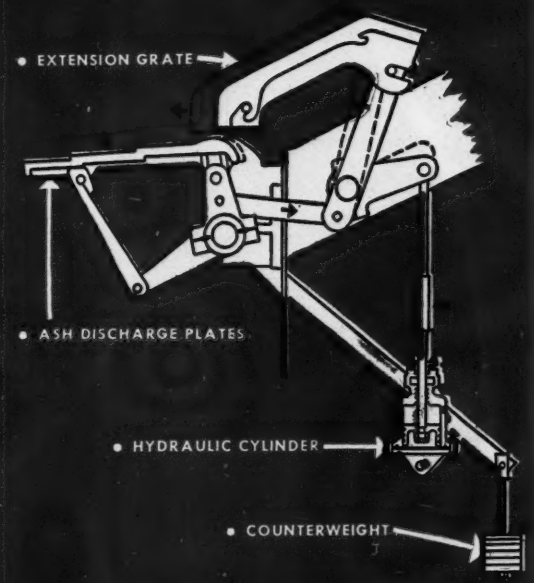
MAY ALTER YOUR POWER OUTLOOK!

The few minutes it will take you to examine the new booklet describing the Improved Æ Taylor Stoker may mean much to you and your company. In it you'll see new features that add years of progress to the design, operation and performance of this time-tested stoker.

You'll see how simplified unit construction reduces installation costs; how the unique continuous ash discharge is automatically timed; how slag formation is minimized; how "finger-tip" ash discharge becomes a reality; how precision feed and better air flow maintain uniformly thorough combustion; how fewer moving, longer wearing parts contribute to lowered steam costs.

You'll see why these improvements in the Taylor Stoker logically provide even greater efficiencies and economies than previously. Before you decide on *any* equipment take time to send for and study this booklet. It will be time well spent.

ANOTHER IMPROVED FEATURE OF THE TYPE "R" TAYLOR STOKER



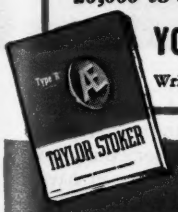
Hydraulically driven independent of the main stoker drive, reciprocating discharge plates provide ash movement ALL-THE-WAY TO THE END OF THE STOKER.

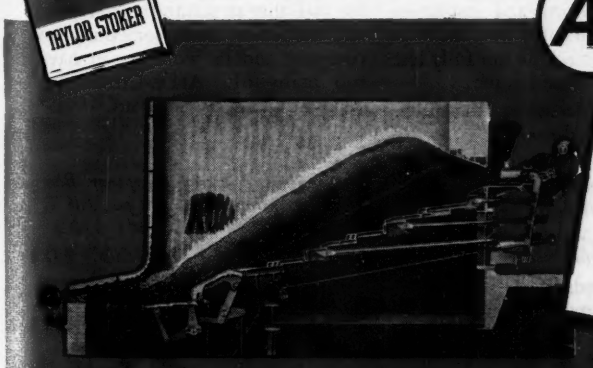
Rearward and slightly upward movement of overfeed section effectively moves ash onto the discharge plates. When overfeed section completes rearward travel, continuation of ash movement to point of discharge is assured by rearward travel of discharge plates.

IF YOUR Steam Requirements Call for 20,000 to 500,000 lbs. per hour—

YOU NEED THIS BOOKLET

Write us. 2408 Aramingo Avenue, Philadelphia 25, Pa.





Æ

Æ TAYLOR STOKERS

AIR-COOLED & WATER-COOLED

AMERICAN ENGINEERING COMPANY

PHILADELPHIA 25, PA.

Meet Mr. Quality

ONE LOOK AT Bill Seebode — 50 year man at Allis-Chalmers Norwood Works — tells you that he sleeps well nights.

One reason is that he and hundreds of his fellow craftsmen at Allis-Chalmers have won *and are keeping* the confidence of engineers and operating men throughout American Industry.

That means a lot to veterans like Bill who've made a career of building great motors.

Bill's a stator-winder, as you can see—a living example of the truism that *men* make motors.

No machine known can assemble the maze of wiring and insulation that goes into a stator with his skill and care. No machine can fully test how *well* he's done his job.

There's only one test... wait 5, 10, 15 years and *see.*

And that's the test that has proved Allis-Chalmers motors are *great* motors. That's why you hear it said so often: *"You can depend on Allis-Chalmers Motors!"*

Yes, hundreds of Allis-Chalmers men—*quality* men like Bill Seebode — know they have a big personal stake in every Allis-Chalmers motor. When they build a great motor for you, they're making a friend... and they know that's something no company and its workers can have too many of. ALLIS-CHALMERS, MILWAUKEE 1, WISCONSIN.

• • •

♪ *Tune in the Boston Symphony, Blue Network, Saturday at 8:30 pm, EWT.*

A 1729

YOU CAN DEPEND ON ALLIS-CHALMERS MOTORS

Stop Wear, Rust and Corrosion with this

BODY-GUARD FOR A BALL BEARING!

THROUGHOUT your busy plant, there are hundreds, perhaps thousands, of grease-lubricated ball bearings like the one shown at the right.

As you know, their efficient operation depends largely upon a grease that continuously covers the highly polished surfaces and provides strong films for protection against wear, rust and corrosion. At the same time, this lubricant must seal out impurities, minimize leakage, make frequent re-packings unnecessary.

Today, in thousands of U. S. plants, Gargoyle Greases BRB, are providing this maximum protection. They are outstanding for their stable structure and their resistance to oxidation and separation over long periods in service.

Get Gargoyle Greases BRB, and be sure your ball bearings have the best body-guards you can buy.

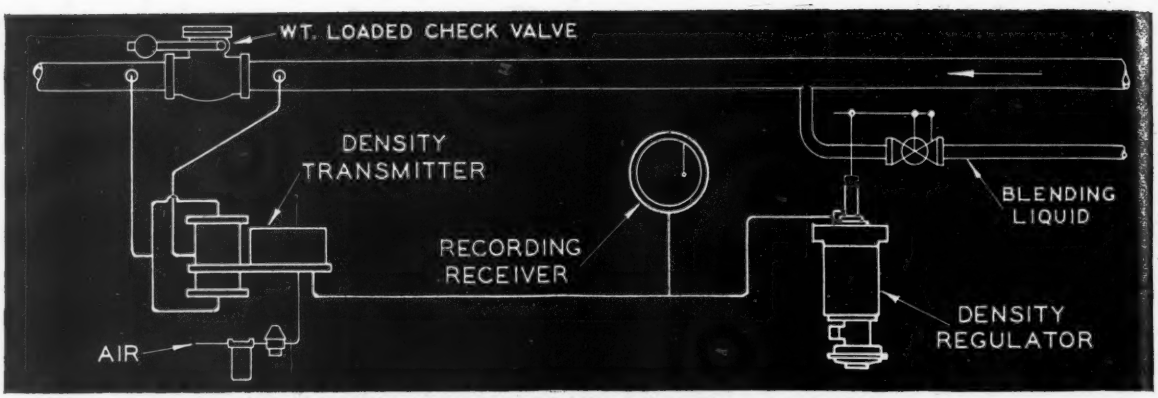
SOCONY-VACUUM OIL CO., INC.
Standard Oil of N.Y. Div. · White Star Div. · Lubrite Div. · Chicago Div. · White Eagle Div. · Wadhams Div. · Magnolia Petroleum Co. · General Petroleum Corp. of Calif.

CALL IN SOCONY-VACUUM FOR "CORRECT LUBRICATION"

GARGOYLE Lubricants

Socony-Vacuum's
5 STEPS
to Lower Production Costs for You!

1. Lubrication Study of Your Entire Plant
2. Lubrication Schedules and Controls
3. Lubricant Storage and Handling System
4. Skilled Engineering Counsel
5. Progress Reports of Benefits Secured



Typical installation for measurement and regulation of density.

REPUBLIC PNEUMATIC LIQUID DENSITY TRANSMITTERS

The Republic Pneumatic Density Transmitter employs the force-balance principle to establish an air pressure which varies proportionately to variations in density of a liquid flowing in a line. The air pressure is therefore a direct measure of the density and can be conducted to a remote location by means of small tubing. A receiver gage connected anywhere in this transmission line will show the variation in the density, and may be used as the impulse for actuating an automatic regulator.

The Transmitter can also be furnished for direct submersion in a tank or vessel, either open to atmosphere or under pressure.

OPERATING ADAPTABILITY

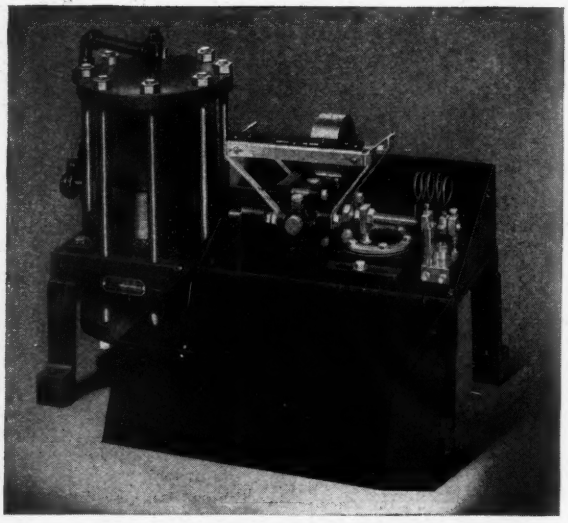
RANGE—Transmitters can be furnished for liquids of densities from 0.5 sp. gr. (compared to water at 60° F.), to the heaviest liquid known.

OPERATING RANGE—Can be as small as 0.05 sp. gr. and this may be from any base density. For example, range may be 0.6 to 0.65; 2.5 to 2.55; etc. Maximum spread may be any amount necessary; e. g.—0.6 to 3.0; 0.8 to 3.5; etc.

RANGE CHANGE—The base density may be changed approximately 3 to 1 by shifting the operating range adjustment weight. For example, the instrument may be built to show a change of 0.05 (or other range spread) above base densities from 0.6 to 1.8, the value of the base density being determined by the position of the adjustment weight.

The spread of the operating range can be changed approximately 3 to 1 by changing the position of the reaction diaphragm along the weighbeam. The base of the reaction diaphragm chamber is slotted to facilitate this change. The spread may be changed approximately 10 to 1 by changing the size of the reaction diaphragm. This change is easily made by changing the diaphragm plates, thereby changing the effective area of the diaphragm.

OPERATING PRESSURE—The standard transmitter is designed for operating pressures to 150 psig. Special designs are available for pressures up to 7500 psig.



The Republic Liquid Density Transmitter with cover open.

PERFORMANCE

ACCURACY—Output pressure vs. measured density is guaranteed accurate to ½ of 1% of range spread.

SENSITIVITY—Since the ratio of available force to effective friction is very large, and the motions required for complete operation are very small, the net dead spot in the mechanism is so small as to be undetectable by ordinary means, being less than 1/20 of 1% of minimum range spread of 0.05 sp. gr.

RESPONSIVENESS—At recommended sampling velocities, 90% of a change in density will register at the transmitter output in 15 seconds.

WRITE FOR BULLETIN NO. 44-10

REPUBLIC FLOW METERS CO.

2240 Diversey Parkway, Chicago 47, Illinois

"BOY— *bring me a pipe stretcher!*"

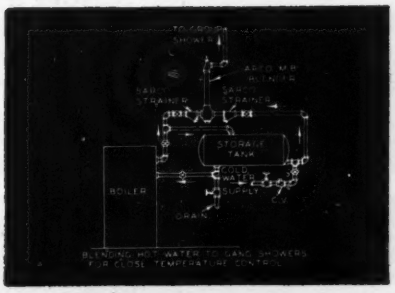
Unreasonable demands are made on the steam engineer every day, and many's the time he would like to call on his helper for tools that would enlarge the capacity of his lines, heating coils, and even the boiler.

The actual fact is that, if the boy came back with a basketful of Sarco steam traps and controls, the job could be done with a pipe cutter and a wrench.

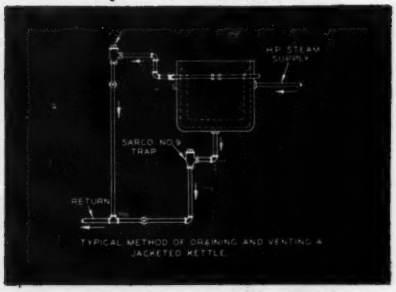
This in a nutshell is Sarco Service — To get more heat to the job by correctly dripping the lines. To use more of the heat before it leaves the coils, by individual trapping, and to regulate temperatures — both in heating and cooling, all over the plant.

Time and again steam process production has been increased 25 to 50%, or the steam used greatly reduced, or the amount of metered water cut 50% or more.

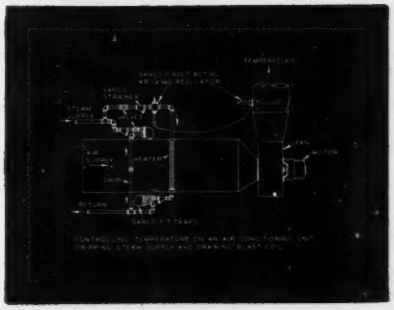
The Sarco Hook-Up book contains a hundred or more ideas, with recommendations and sketches, and tells how each Sarco product will fit into your plant operation. Why not send for it now?

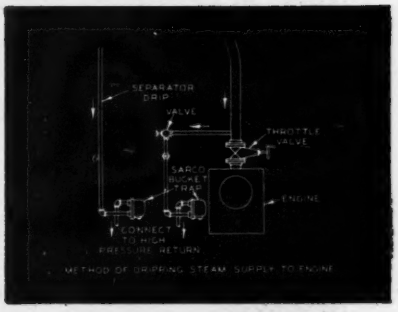


BLENDING HOT WATER TO GANG SHOWERS FOR CLOSE TEMPERATURE CONTROL

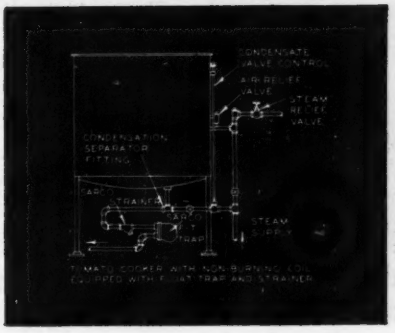


TYPICAL METHOD OF DRAINING AND VENTING A JACKETED KETTLE

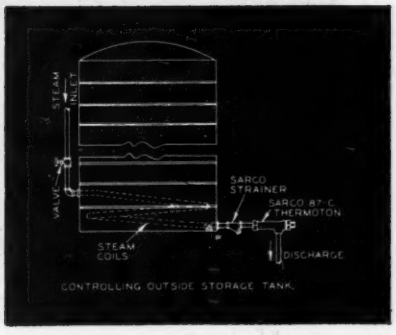

CONTROLLING TEMPERATURE ON AN AIR CONDITIONING UNIT DRIPPING STEAM SUPPLY AND DRAINING BLAST COIL



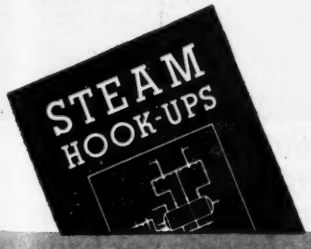
METHOD OF DRIPPING STEAM SUPPLY TO ENGINE



TYPICAL COOPER WITH NON-BURNING COIL EQUIPPED WITH FLOAT TRAP AND STRAINER



CONTROLLING OUTSIDE STORAGE TANK



SARCO COMPANY, INC.
475 FIFTH AVENUE
NEW YORK 17, N. Y.
Represented in Principal Cities

SARCO Saves Steam

SARCO CANADA, LTD., 85 Richmond Street, West, TORONTO, ONTARIO

34

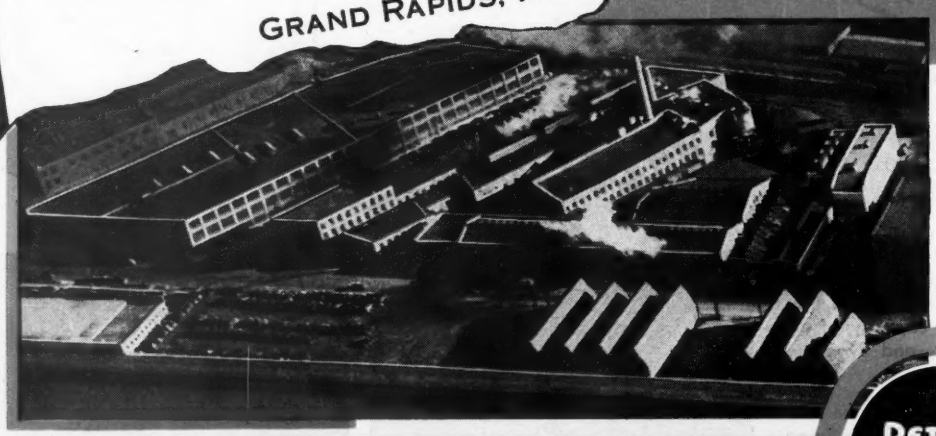
AMERICAN BOX BOARD COMPANY

FOLDING PAPER BOXES
FIBRE SHIPPING CONTAINERS
CORRUGATED SHIPPING CONTAINERS

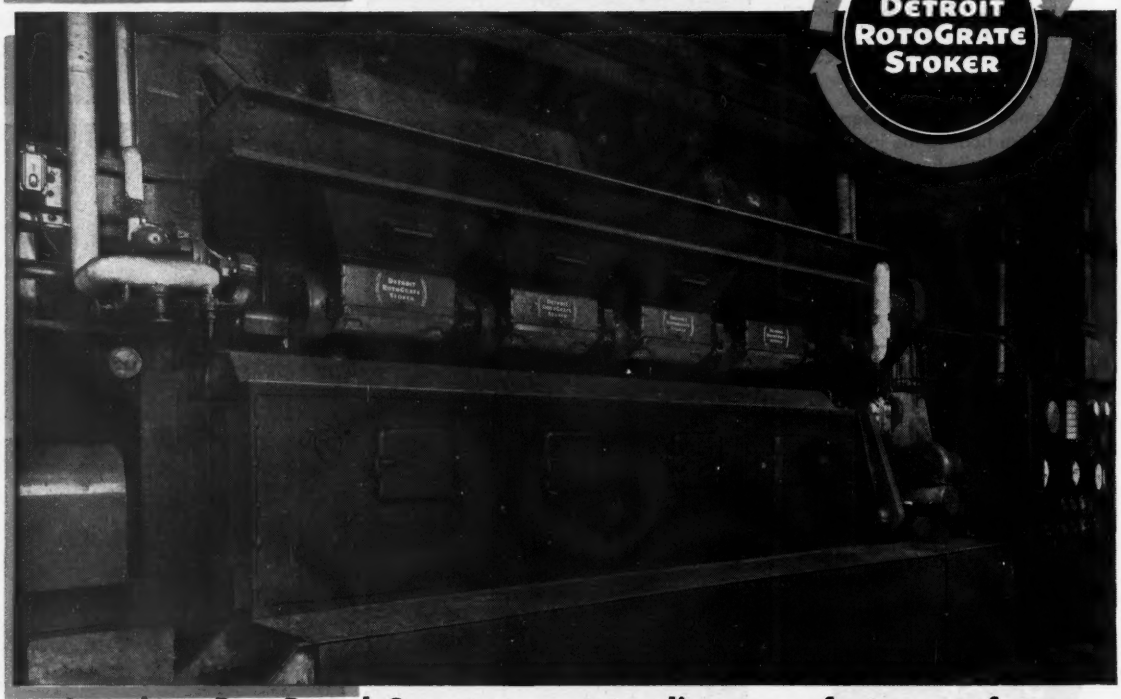
STRAW BOARD
SUIT BOX BOARDS
HIGH TEST LINERS AND CHIP

GRAND RAPIDS, MICH.

REPORTS



DETROIT ROTOGRATE STOKER



American Box Board Company, outstanding manufacturers of container board and containers, use a RotoGrate Stoker applied to a three drum steam generator, with economizer, air heater and superheater, continuous rated capacity 110,000 pounds of steam per hour. RotoGrate reported carrying entire plant load.

DETROIT STOKER COMPANY

OVER 86% EFFICIENCY

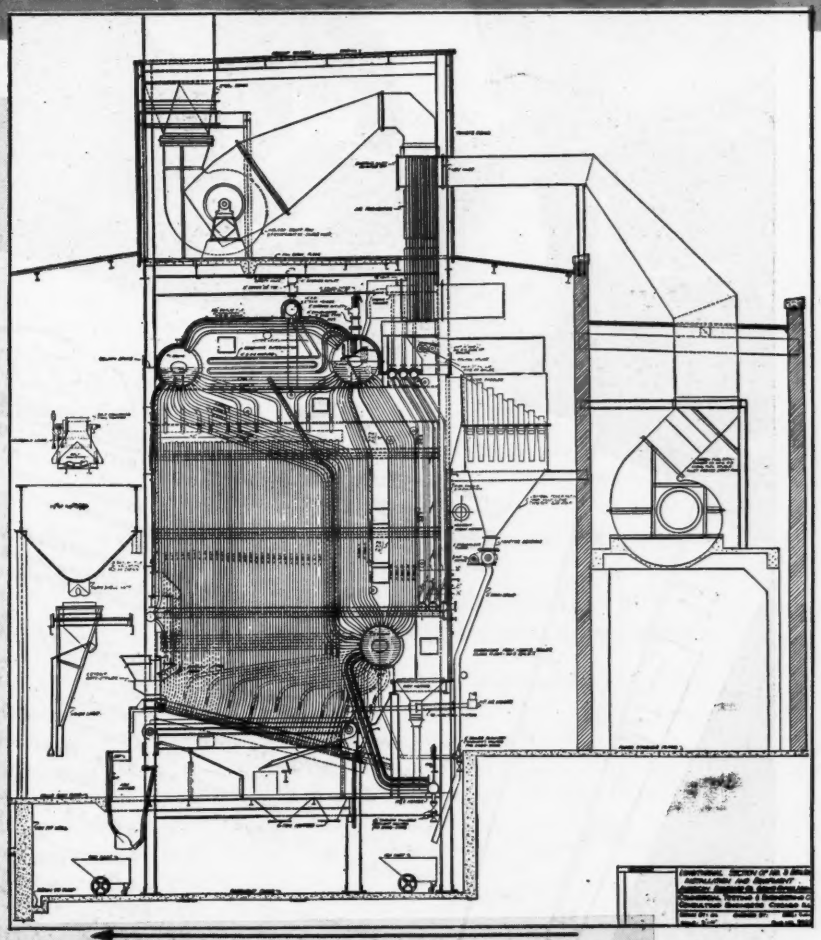
DETROIT ROTOGRATE STOKER

Steam Generator and RotoGrate Stoker:

110,000# hr. continuous capacity • 200# pressure • 490° F. steam temperature • 230° F. Feed Water temperature 240° F. air for combustion.

Heating Surfaces:

Boiler	11900 sq. ft.
Water walls	2597 sq. ft.
Economizer	3040 sq. ft.
Superheater	1220 sq. ft.
Air heater	6010 sq. ft.



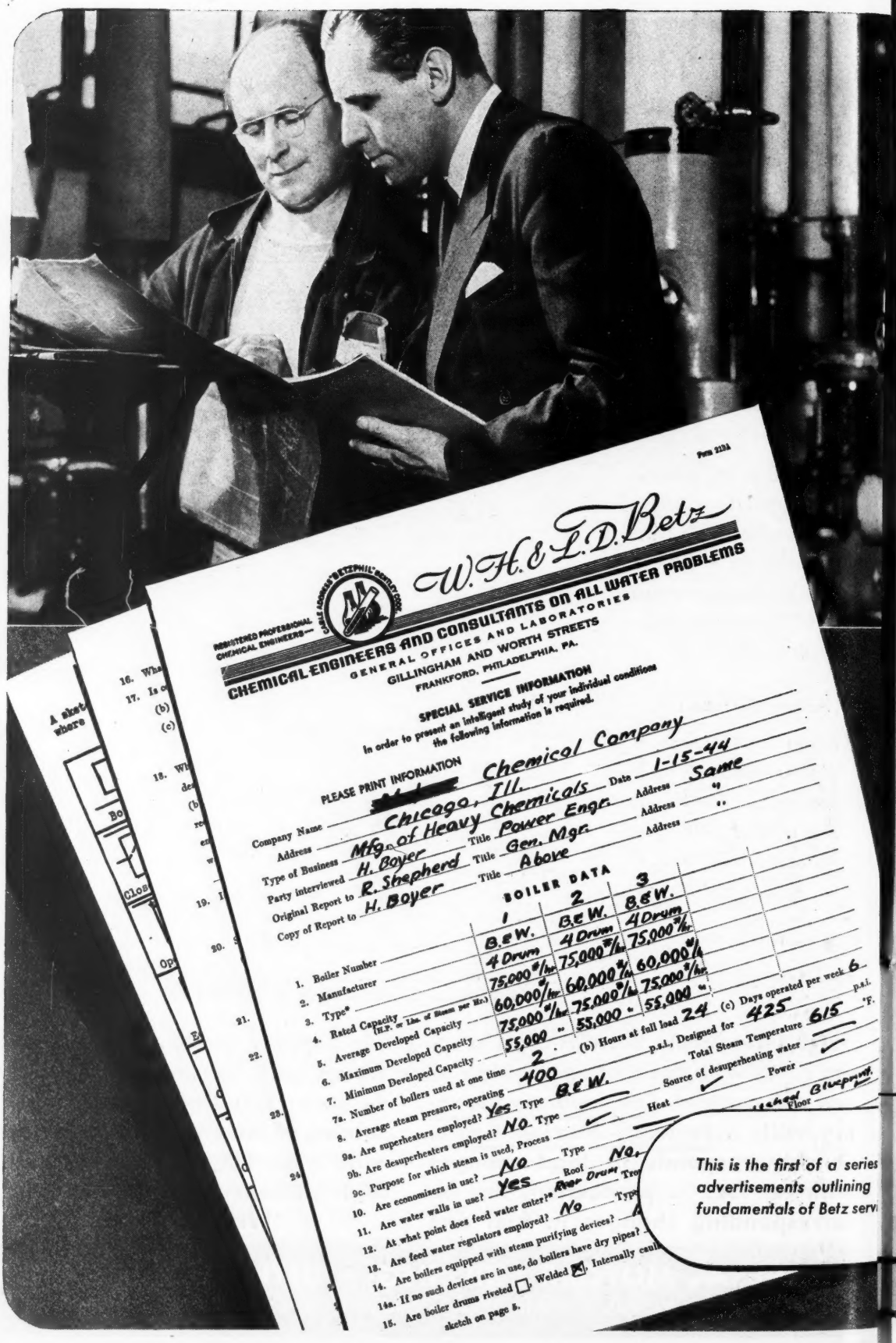
CONTINUOUSLY CLEANING GRATE MOVES FORWARD

Detroit RotoGrate permits high burning rates with fuels of either high or low ash content. *Continuously Cleaning* with a *Forward Moving Grate.* Quickly responds to load changes with no loss in production, due to corresponding changes in fuel and air supply. Overfire air is proportioned to undergrate air, producing furnace turbulence and thorough mixing of the products of combustion, with high CO_2 and correspondingly high efficiency at all ratings.

Write for Bulletin

GENERAL MOTORS BUILDING • DETROIT 2, MICHIGAN

Works at Monroe, Michigan • District Offices in Principal Cities • Built in Canada at London, Ontario


REGISTERED PROFESSIONAL CHEMICAL ENGINEERS—
CABLE ADDRESS "BETZPHIL" PHILADELPHIA
W. H. & L. D. Betz
CHEMICAL ENGINEERS AND CONSULTANTS ON ALL WATER PROBLEMS
GENERAL OFFICES AND LABORATORIES
GILLINGHAM AND WORTH STREETS
FRANKFORD, PHILADELPHIA, PA.
Form 2134
SPECIAL SERVICE INFORMATION
In order to present an intelligent study of your individual conditions the following information is required.
PLEASE PRINT INFORMATION
Company Name [redacted] Chemical Company
Address Chicago, Ill. Date 1-15-44
Type of Business Mfg. of Heavy Chemicals Address Same
Party interviewed H. Boyer Title Power Engr. Address "
Original Report to R. Shepherd Title Gen. Mgr. Address "
Copy of Report to H. Boyer Title Above
BOILER DATA
1 2 3
1. Boiler Number B.&W. B.&W. B.&W.
2. Manufacturer 4 Drum 4 Drum 4 Drum
3. Type* 75,000#/hr 75,000#/hr 75,000#/hr
4. Rated Capacity (H.P. or Lbs. of Steam per Hr.) 60,000#/hr 60,000#/hr 60,000#/hr
5. Average Developed Capacity 75,000#/hr 75,000#/hr 75,000#/hr
6. Maximum Developed Capacity 55,000 " 55,000 " 55,000 "
7. Minimum Developed Capacity
7a. Number of boilers used at one time 2 (b) Hours at full load 24 (c) Days operated per week 6
8. Average steam pressure, operating 400 p.s.i., Designed for 425 615 p.s.i.
9a. Are superheaters employed? Yes Type B.&W. Total Steam Temperature °F.
9b. Are desuperheaters employed? No Type Source of desuperheating water
9c. Purpose for which steam is used, Process Heat Power
10. Are economisers in use? No Type
11. Are water walls in use? Yes Roof Rear Drum Floor
12. At what point does feed water enter?* No
13. Are feed water regulators employed? No
14. Are boilers equipped with steam purifying devices?
14a. If no such devices are in use, do boilers have dry pipes?
15. Are boiler drums riveted ☐, Welded ☒, Internally
sketch on page 5.
This is the first of a series
advertisements outlining
fundamentals of Betz serv

HOW BETZ BOILER WATER CONDITIONING IS BUILT *Exactly for You*

• It is a well-known fact that no two boiler plant operations can ever be identical, and it is upon this premise that Betz extends its supervisory service for industrial boiler water conditioning.

On the facing page is shown a part of the Information Sheets used by Betz chemical engineers in surveying individual boiler plant operations. Six pages in number, these sheets provide for answers to over 100 questions pertaining to specific boiler data, feed water heating, water and fuel data, internal condition of boilers, present internal and external treatment, etc. The completeness of these plant studies may be illustrated by the following partial list of points investigated on one factor only, namely, the feed water heating:

1. *Type of feed water heater in use*
2. *If deaerating heater, the temperature of water leaving heater and back pressure*
3. *If closed heater, the temperature of water at point last vented to atmosphere*
4. *Residual oxygen content of water leaving heater*
5. *Proportion of live to exhaust steam used in heater*
6. *Amount of exhaust steam available*
7. *Height of heater water level above feed pump*
8. *Plant experience as to steam binding of pumps*
9. *Type of oil separators employed with feed water heater*

This information together with a diagram of the steam/water flow throughout the plant, a diagram of the type boiler, and detailed sketches showing point of feed-water entrance, continuous blow take-off, internal baffling, point of chemical feed, etc. is sent to our laboratories where the information is studied and correlated with the analyses of water samples obtained at the plant. We then prepare a comprehensive report of findings with recommendations for proper chemical treatment and control, which is submitted to the power plant engineer for his further study. This complete plant investigation and report is our first step in rendering a detailed supervisory service.

It is the constant aim of the Betz organization to render a complete, detailed and individual supervisory service for boiler water conditioning—a service to achieve these results: the prevention of boiler scale; prevention of economizer and feed line deposits; elimination of corrosion and pitting throughout the system; prevention of foaming, priming and carryover; prevention of embrittlement; economy of blowdown; general operating efficiency.

W. H. & L. D. BETZ

Gillingham & Worth Sts., Frankford, Philadelphia 24, Penna.

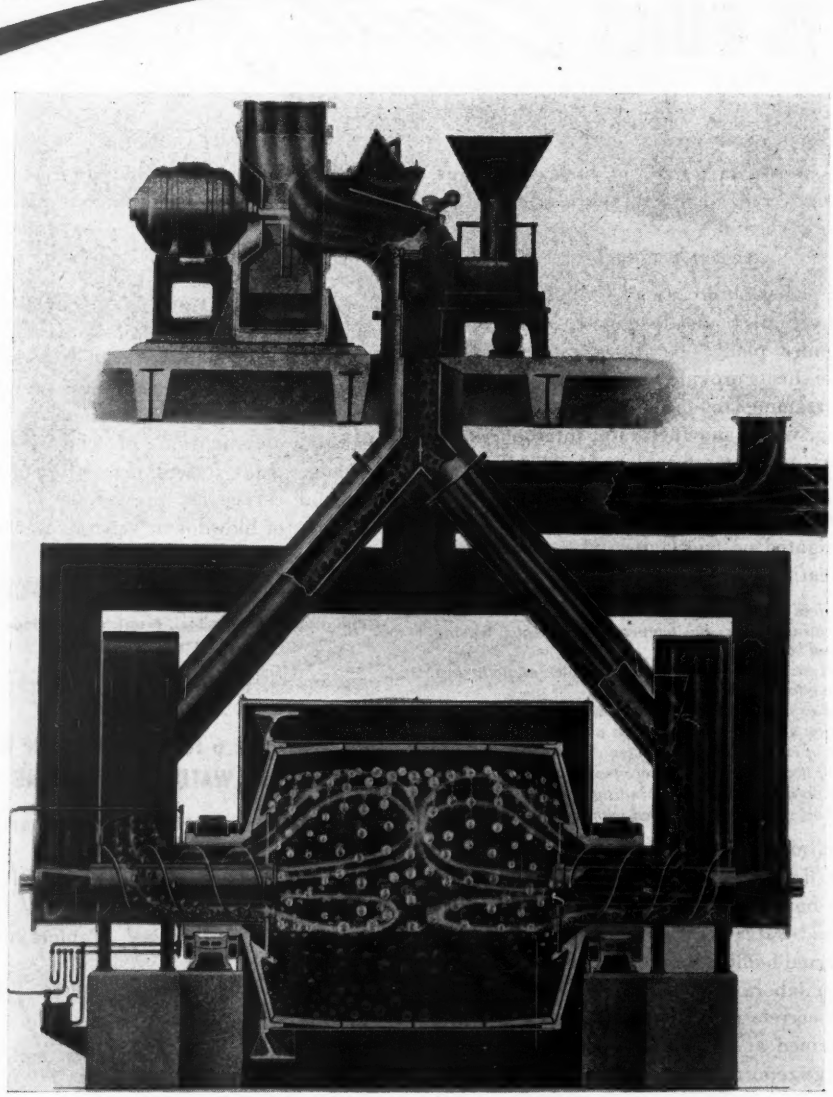
THE 6 FUNDAMENTALS OF BETZ BOILER WATER CONDITIONING SERVICE

1. **Complete plant investigation and report**
2. Establishment of plant control
3. Daily plant control tests
4. Detailed review of plant tests and report
5. Supplementary complete laboratory analyses
6. Periodic "check-up" visits

CHEMICAL ENGINEERS AND CONSULTANTS ON ALL WATER PROBLEMS

BETZ

Continuous FINE GRINDING



Fine grinding and Full Capacity are obtained without dependence on close clearances between moving parts. New Ball charge (the grinding medium) is added during operation as necessary, thus eliminating shut-downs to replace the pulverizing parts.

FW FOSTER

NGof PULVERIZED FUEL GIVES HIGHER BOILER EFFICIENCY

The outstanding performance characteristic of Foster Wheeler (Hardinge type) Ball Pulverizers is maintenance of high fineness in the pulverized fuel — over long periods of service without loss in capacity.

This exceptional ability to operate without reduction in fineness or forced outage, effects material savings including:

1. Boiler efficiency maintained for duration of run with resultant low cost for fuel.

2. Boiler outages for cleaning heating surfaces reduced; pulverizer repairs minimized.

3. Labor charges against cleaning boiler and water wall surfaces sharply decreased.

FOSTER WHEELER CORPORATION, 165 Broadway, New York 6, N. Y.

WHEELER FW

Victory Will Mean

NEW JOBS *for* STEAM

Steam will blow the whistles when the big news comes. But, in heralding the great day, steam will have done far more than sound the signal for rejoicing.

Beyond steam's part in victory . . . beyond its record of powering ships, trains, war plants, there will be thousands of stories of men . . . *engineers* . . . men with trigger minds instead of trigger fingers . . . who tackled power plant problems with keen resourcefulness so that power for war needs would never be "too little or too late". With the end of hostilities will come new Victory jobs for steam . . . new problems . . . keener competition that will put emphasis on operating costs.

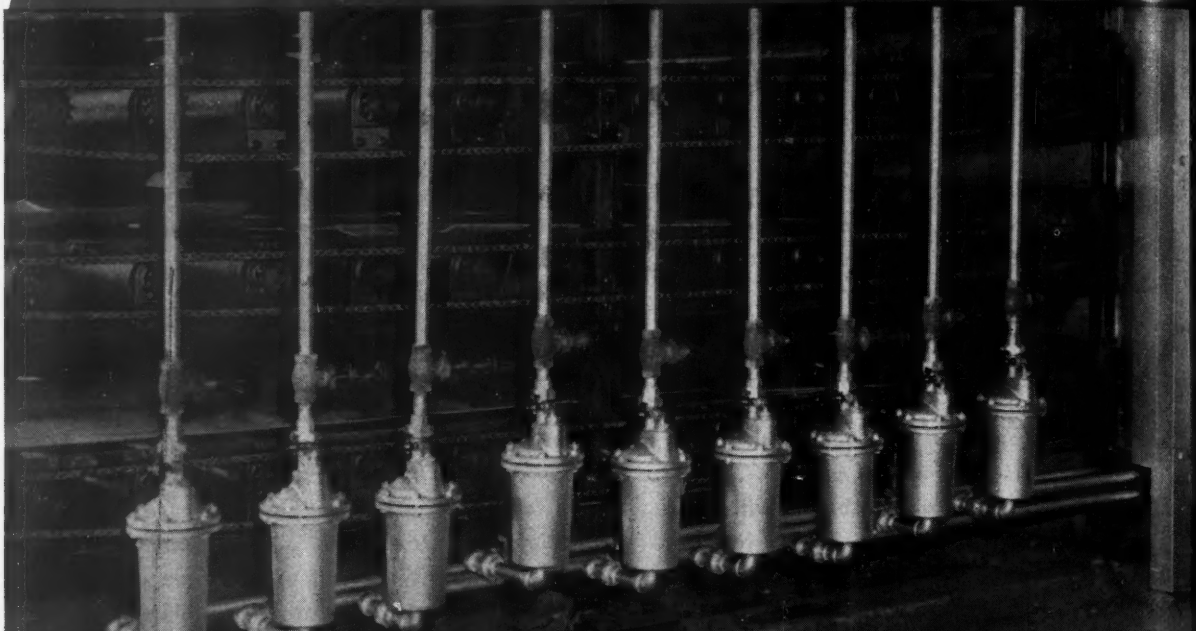
With today's accelerated experience yielding more complete answers to such problems as behavior of metals at high temperatures, action of fuels in slag-tap and dry-ash furnaces, circulation in high-capacity high-pressure boilers, separation of steam from water in boiler steam drums, and other related problems, the boilers of tomorrow will be even better able to serve industry.

Building boiler units complete with all essential components . . . controlling both the design and the application of the equipment fabricated . . . these, plus extensive facilities, give us at B&W a background that's unique. As a result our engineers have at their disposal an array of boilers from which to meet any combination of conditions of capacity, pressure, temperature, feedwater, fuel, and space. Now is a good time to consult with us regarding your steam plant requirements for the future.

Army-Navy "E" flags have been awarded to five B&W plants, and also the Maritime Commission Award flags to the Barberton, Ohio, Plant.

THE BABCOCK & WILCOX CO.
85 LIBERTY STREET, NEW YORK 6, N. Y.

"ENOUGH COAL FOR 3000 YEARS"



How Important *Are* Steam Traps? *Read These Records of Coal Savings*

LAUNDRY CUTS FUEL COSTS 35% Peerless Laundries, Ltd., Los Angeles, one of the world's largest laundries, reduced heating-up time by 30 minutes, reduced maintenance costs 8% by installing Armstrong Traps.

27% FUEL SAVING AT HOTEL— Mount Washington Hotel, Bretton Woods, N. H., experienced 27% reduction in fuel consumption the first year after Armstrong Traps were installed.

CUTS COAL BILL $650 ANNUALLY —A Huntingburg, Ind., firm spent $417 for Amrstrong Traps and saved $650 on coal the first year they were installed.

STORE EQUIPMENT CONCERN SAVES 170 TONS COAL— At the Northwestern Store Equipment Corp., Milwaukee, Wis., Armstrong Traps save 170 tons of coal per year, heating-up time on wood drying kilns cut from 5½ hours to 2½ hours, and back pressure on steam engine used to drive line shafting dropped from 7 - 10 lbs. to 2 lbs.

GREENHOUSE SAVES $1067 ON COAL IN ONE YEAR by using Armstrong Traps. This unit trap installation saved 220 tons of coal per year.

HIGH SCHOOL CUTS COAL CONSUMPTION 50% — The Springfield City High School, Springfield, Ohio, reduced coal consumption from 8-9 tons per day to 4, by installing 30 Armstrong Traps.

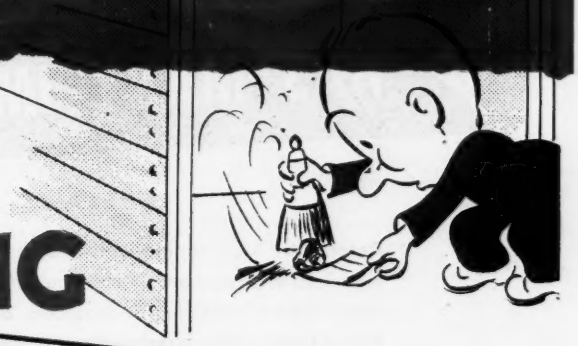
TRAPPING SAVES MUNICIPALITY $2600 A YEAR— Oil City, Pa. saved exactly $2651.42 in fuel the first year Armstrong Traps were installed at the city water pumping station.

PLYWOOD COMPANY SAVES CARLOAD OF COAL PER WEEK— Atlas Plywood Corp. of Canada Ltd., Waterloo, Quebec, effected this saving by installing Armstrong Traps. Believe it or not this company has effected a 100% savings on coal purchases, since the coal was supplementary to a waste wood supply.

ARMSTRONG SAVES CANVAS GOODS MANUFACTURER 50% FUEL COSTS— Couch Bros. Mfg. Co., East Point, Ga., used only 4½ tons coal for heating purposes instead of 9, after installing Armstrong Traps.

ARMSTRONG *Inverted Bucket*

. . . may not do you any good today!



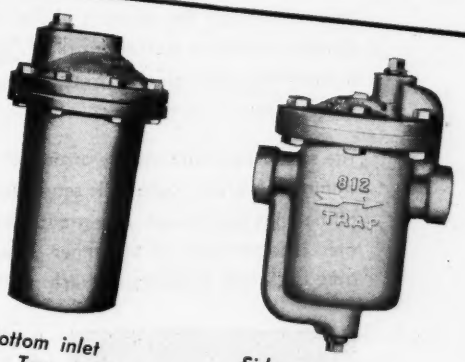
conserve it with ARMSTRONG STEAM TRAPS

**A recent estimate of bituminous coal deposits in the United States indicated that there is enough for another 3000 years, but it's the coal in your bin that counts today.*

Armstrong Traps save coal because they don't leak steam . . . because they discharge condensate as rapidly as it accumulates . . . because they automatically vent air—thereby allowing the steam to give up its heat where it is supposed to for productive results.

Armstrong Steam Traps are available for all services and all pressures. Sold by leading distributors and jobbers everywhere. Guaranteed to satisfy. Over a million in use. Write for 36-page STEAM TRAP BOOK.

ARMSTRONG MACHINE WORKS
810 Maple St., Three Rivers, Michigan



Bottom inlet Top outlet

Side inlet — Side outlet

FEATURES:

1. Stainless Steel bucket and lever system.
2. Chrome steel valve and seat — hardened, ground and lapped.
3. Frictionless leverage system.
4. Swirling action of condensate cleans out all ordinary dirt and scale.
5. Choice of body styles.
6. Automatic air elimination.
7. Every trap factory tested.

STEAM TRAPS for POWER PROCESS HEATING

DIAMOND *Automatic Sequentia*

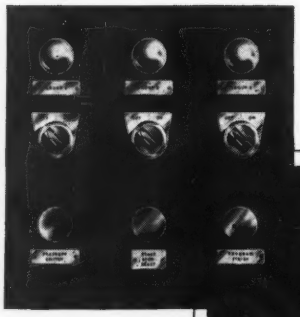
HAS MANY IMPORTANT ADVANTAGE

Description—All soot blower units on the boiler, superheater, economizer and air heater (whether fixed element, retracting or telescopic) are controlled from a single panel such as the one shown below. To begin the cleaning of the entire unit, simply press one button marked "start;" all blowers then operate in correct sequence without attention.

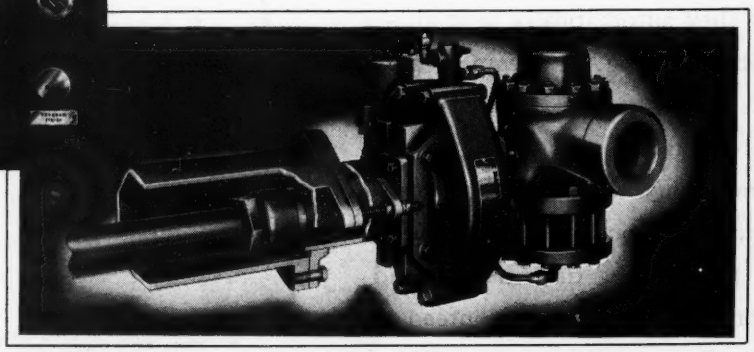
The soot blowers are usually arranged in groups; within each group, automatic sequential blowing of the units takes place. Any group can be operated independently of any other group if desirable by simply throwing a switch on the control panel. Blowing sequence of the units in any group can also be easily changed to suit conditions.

The compressed air for cleaning is discharged from the element nozzles in a series of short puffs. At each puff, the element is automatically repositioned. Spreading the cleaning cycle over a longer period of time permits use of a very small compressor.

The Diamond Automatic Sequential Soot Blower System has been in central station use on boilers as large as 900,000 lb/hr units since 1940. Its many important features are discussed on the right-hand page.



Program panel at left controls both fixed and retracting blowers arranged in three groups; any desired number of groups can be had when system is designed. Entire soot blowing system is operated in correct sequence by simply pushing "start" button.



Shown above is the Diamond Air Puff Soot Blower having element permanently installed inside the setting; various types of retracting soot blowers are also used in the Diamond Automatic Sequential Air Soot Blower System.

DIAMOND POWE

IR SOOT BLOWER SYSTEM

CORRECT CLEANING ASSURED — 1

The "human element" is entirely eliminated from soot blowing; the automatic sequential operation assures positive operation of each blower unit in correct sequence and at right speed every time. No blower unit can be overlooked by careless operator.

SAVES LABOR — 2

Automatic sequential operation eliminates need for an attendant to drain the piping, warm it up, and then operate each individual blower unit. On one medium size boiler this labor saving is estimated at more than $3000 per year.

NO FEED WATER MAKEUP — 3

Using compressed air instead of steam as the cleaning medium, there is no condensate loss due to soot blowing. This is particularly important where makeup water is a problem.

SAVES FUEL — 4

Experience gained during several years' operation on a number of installations indicates that automatic sequential air puff soot blowing uses only ⅓ to ⅔ of the energy from the coal pile that is needed for steam blowing.

ELIMINATES STACK DISCHARGE NUISANCE — 5

Intermittent operation expels the soot from the boiler in small quantities that are readily handled by the dust collector. In an installation without dust collectors, it has permitted daylight blowing in a metropolitan district having a smoke abatement ordnance.

REDUCES MAINTENANCE — 6

Experience on two 900,000 lb/hr boilers placed in operation in 1940 and one 900,000 lb/hr and one 550,000 lb/hr units installed in 1942 has proved the maintenance cost is unusually low.

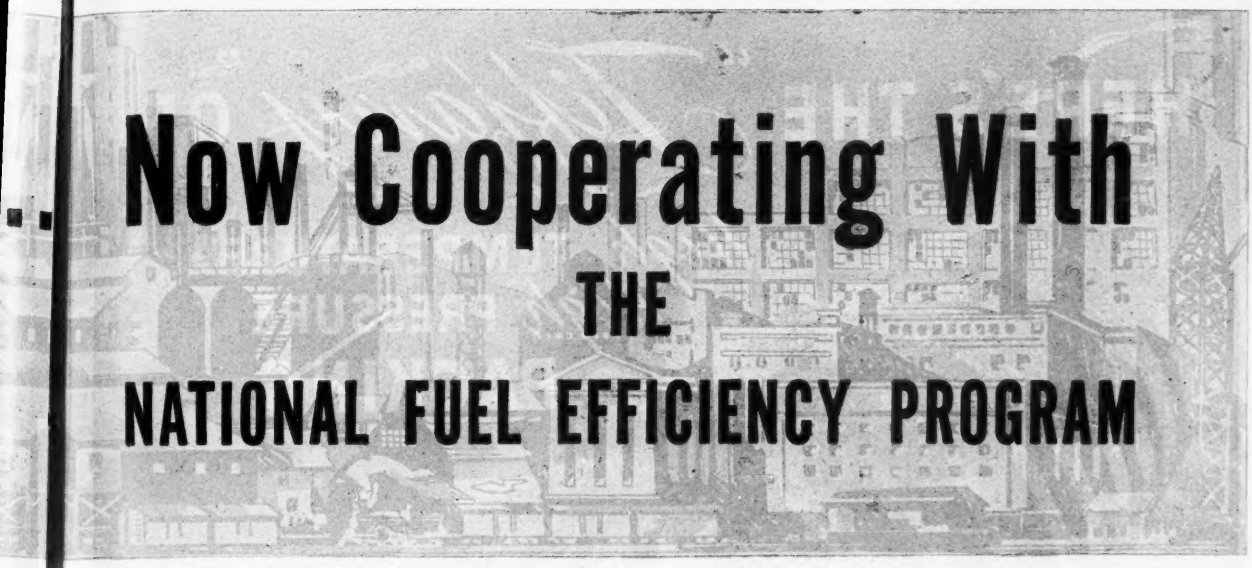
Among the other advantages is the theoretically better cleaning with air from a given nozzle because of the greater density of air. If you are interested in further information, ask for Bulletin No. 956 which illustrates and describes an installation of Diamond Automatic Sequential Air Puff Blowers in a prominent eastern central station.

SPECIALTY CORP. DETROIT 31, MICHIGAN

DIAMOND SPECIALTY LIMITED · Windsor, Ontario

Over 7,500 Fuel Users..

NATIONAL FUEL EFFICIENCY PROGRAM
is carried on in cooperation with United States Department of the Interior.
BUREAU OF MINES



Now Cooperating With THE NATIONAL FUEL EFFICIENCY PROGRAM

Indicative of the good results that are being accomplished by the National Fuel Efficiency Program, over 7500 industrial and commercial fuel users have already pledged their cooperation with this nation-wide movement.

The National Fuel Efficiency Program is a voluntary organization set up under the U. S. Department of the Interior, Bureau of Mines, to help stretch the inadequate fuel supply of the nation by promoting greater fuel efficiency and reducing energy losses. The field force now comprises 184 local coordinators directing more than 5,000 Regional Engineers who visit cooperating plants and aid plant engineers and executives in finding and stopping "leaks" in equipment or practices which may be wasteful of fuel.

The more than 7500 "fuel users" who have also become "fuel savers" are evidence of the growing interest which the Program is arousing among thoughtful plant executives — an interest which must spread and develop to gain the active cooperation of *every* fuel user if serious fuel shortages are to be averted.

For the welfare of your own plant, as well as that of the national war effort, won't you cooperate with the National Fuel Efficiency Program? If, because of the burden of work involved, a Regional Engineer hasn't reached your plant yet, it is suggested that you take the initiative by writing to your local Coordinator, or to the National Fuel Efficiency Section, Bureau of Mines, U. S. Department of the Interior, Washington 25, D. C. A-851

• • •

As specialists in the design and manufacture of equipment for efficient, economical steam generation, Combustion Engineering heartily endorses this Program which so closely parallels its own activities, and is glad to donate this advertising space to further the cause.

COMBUSTION C-E ENGINEERING

200 MADISON AVENUE NEW YORK 16, N. Y.

C-E PRODUCTS INCLUDE ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

HERE'S THE "Tiffany" OF High TEMPERATURE – High PRESSURE PACKING

Core: Vulcanized pure asbestos fibers, thoroughly graphitized.

Braided Asbestos Jacket: reinforced with monel wire.

JOHN CRANE Style 6-AM

Large steel plant, Youngstown, Ohio:

"6-AM installed in open hearth valves. No difficulty."

Cleveland steel mill:

"Open hearth valves still packed after 9 months. Exceptional service."

Large high-pressure power plant, Painsville, Ohio:

"Excellent service with steam on stop valves at 2000 p.s.i., 650° F. and superheated 300°. Have standardized on 6-AM."

Operating Engineers: Order spirals, coils, spools, die-formed rings or sets.

CRANE PACKING COMPANY

1812 CUYLER AVENUE • CHICAGO 13, ILLINOIS

What do you want to know about Turbine Oil?

Recently a number of utility plant men were asked, "What do you want to know about turbine oil?" Several of them had very specific questions. They are answered here because they may help you in selecting a turbine oil that solves, once and for all, the ever present problem of turbine oil maintenance. One question is taken up each month, but you can get the answers to all of them now—see the booklet offer.

6. What causes corrosion in turbines?

Corrosion, like acidity and deposit trouble, in turbines is a complex problem. A complete explanation of its causes would require a review of turbine developments and a thorough knowledge of the various types of corrosion that may occur in turbines. Briefly, here's what has brought about the corrosion which has bothered some turbine operators in recent years.

As turbine efficiency was improved over the years by higher steam pressures and temperatures, oils that had been satisfactory for older turbines began to form sludge and other deposits. To eliminate these deposits, more highly refined oils were introduced. But the higher degree of refining, which removed some of the deposit-forming elements, also removed natural corrosion inhibitors from the oil. This resulted in a new and serious type of corrosion.

There are two types of corrosion. Common rust (Fe_2O_3) is the most familiar type. It occurs on ferrous metal parts such as storage tanks, reservoirs, and oil lines where there is moisture above the oil level, or where water accumulates in pockets and depressions. This type does little damage unless allowed to continue over a period of years. Parts subject to such damage are sometimes treated with special protective coatings.

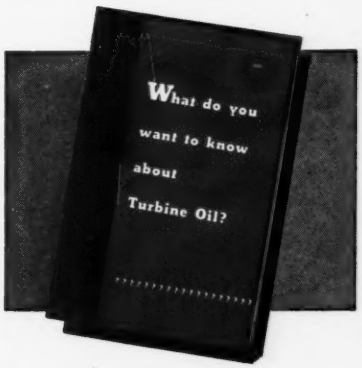
The most serious type of corrosion which has developed in recent years is caused by water carried in suspension in the oil. Even a small percentage of moisture—as low as 0.1%—will cause this corrosion. It forms dense, hard crystals of magnetic iron oxide (Fe_3O_4) which are highly abrasive and severely score bearings—can clog oil lines and governor mechanisms in short order.

Hundreds of tests were made in Standard Oil laboratories to find an additive which would give complete protection against corrosion. Many products were excellent as rust preventives, but because of high acidity, poor demulsibility, etc., could not be used without impairing the other necessary qualities of a turbine oil. For example, used oils give protection against certain types of corrosion. But when added to new oil, even in small quantities, these used oils accelerate acidity and deposit formation.

From these tests, however, emerged a thoroughly satisfactory corrosion inhibitor for turbine oil. This inhibitor is used in Nonpareil in addition to the oxidation inhibitor. Recently the American Society for Testing Materials developed test D665-42T for determining the ability of turbine oil to aid in preventing the rusting of ferrous parts in the presence of water. Nonpareil Turbine Oil is manufactured to pass this test with perfect results. The corrosion inhibitor in Nonpareil does not affect its resistance to deposit formation, or its guarantee to eliminate excessive oil acidity "for the life of your turbine."

Gasoline Powers the Attack . . .

Don't Waste a Drop!



For all the answers send for this booklet... it contains answers to questions such as these:

1. What causes turbine oil deposits or sludge?
2. What causes acidity increase in turbine oil?
3. What is an oxidation inhibitor—how does it prevent acidity?
4. How does a guaranteed turbine oil protect the user?
5. Does the inhibitor in Nonpareil Turbine Oil wear out?
6. What causes corrosion in turbines?

Send for a copy of this booklet, or better still, ask for a Standard Lubrication Engineer. He can answer your specific questions about Nonpareil Turbine Oil. Write Standard Oil Company (Indiana), Room 1223, 910 S. Michigan Ave., Chicago 80, Ill., for a copy of the booklet, or the Engineer nearest you.

NONPAREIL TURBINE OIL

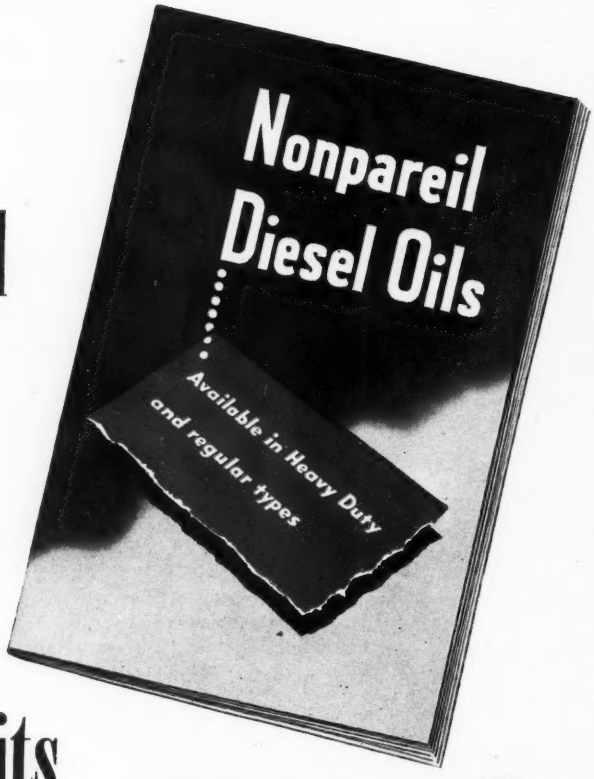
STANDARD OIL COMPANY (INDIANA) STANDARD SERVICE

★ LUBRICATION ENGINEERING

LUBRICATION ENGINEERING . . . LUBRICATION ENGINEERING . . . LUBRICATION ENGINEERING . . .

LUBRICATION ENGINEERING . . . LUBRICATION ENGINEERING . . . LUBRICATION ENGINEERING . . . LUBRICATION ENGINEERING . . .

Eliminate stubborn and troublesome varnish and sludge deposits with . . .



For Industrial Diesels

For Railroad Diesels

NONPAREIL
DIESEL OILS

Gasoline Powers the Attack . . . Don't Waste a Drop!

Send for this booklet!

It tells why the heavy-duty, detergent grades of oil were added to the Nonpareil line of Diesel Oils, and how they insure engine cleanliness even under the adverse operating conditions of today.

It contains useful information such as: hints on filtering of heavy-duty oil, and tables on cooling water recommendations of various Diesel manufacturers. Write the nearest local Standard Oil Company (Indiana) office, or 910 South Michigan Avenue, Chicago 80, Illinois, for this brief factual booklet on Diesel lubrication.

STANDARD OIL COMPANY (INDIANA)

STANDARD SERVICE

COPPER ALLOY BULLETIN

MARINE AND POWER EDITION

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared by Bridgeport Brass Company "Bridgeport" *Headquarters for BRASS, BRONZE, and COPPER*

Highly Corrosion-Resistant Copper-Base Alloys

for Marine Refrigeration and Air Conditioning

With the war has come new realization of the vital roles which refrigeration and air conditioning play on board surface ships and submarines. In addition to food preservation, the air conditioning of large portions of living and working space, maintenance of proper humidity and temperature control for stored ammunition and other material are factors of the greatest importance. Marine refrigeration and air conditioning undoubtedly will be used even more widely in the future.

Many Future Benefits

The successful shipment of perishable foods to our fighting men overseas is only a prelude to what promises to be a tremendous industry in the postwar years. Quantities of foodstuffs will be preserved during their journey across vast oceans by large, efficient refrigeration and air conditioning installations. Fishing vessels will be equipped to "deep freeze" while at sea. The natural goodness of tropical fruits and vegetables will be preserved by more effective refrigerating technics. Crews and and passengers will enjoy the benefits of more healthful living and working quarters through more general use of air conditioning equipment.

Corrosion Worse On Shipboard

Copper-base alloys play an important part in the pumps, motors, piping, tubing, controls, ducts, nuts, bolts, fastenings, and other equipment involved in such installations. However, at this time let us consider only those applications involving piping and tubing together with the corrosion problems encountered. Tubing corrosion problems are intensified on board ship because circulating sea water is used in condensers and coolers, and because the effects of condensation on the surface of pipes is more severe in the presence of salt laden air.

Other corrosion problems are encountered in refrigeration as the liquid refrigerant, such as Freon is conducted through tubing or piping to the point of vaporization, compressed to a higher temperature level, then conducted through tubing or pipes to a condenser, where the hot gases are cooled and condensed by flowing on the outside of tubes through which sea water is circulated. Here impingement corrosion is encountered when water velocities are high.

Many Factors In Tube Selection

The pipes and tubing involved in this cycle must, of course, be carefully selected. For condensers in refrigerating systems where water velocities are not too high, an alloy like Arsenical Admiralty gives satisfactory service with salt water. With higher velocities, Cuzinal (Aluminum brass) with its superior resistance to air impingement, gives better results than Admiralty. For severe conditions, Duronze IV has exceptional resistance to general corrosion and impingement attack, and is considered one of the finest condenser tube alloys made. Cupro Nickel is recommended in connection with high velocity clean sea water when impingement corrosion is very severe.

While Duronze IV is particularly recommended for surface condensers in power plants where water conditions are exceptionally bad, it might well be a good choice for condenser tubing in refrigeration installations on coast line ships, traveling continually in waters where corrosion is intensified by wastes from cities.

Consider Type of Refrigerant

Other piping and tubing in refrigeration and air conditioning systems require equally careful consideration. Where ammonia refrigerants are used, for example, it is obvious that a leak aboard ship might have extremely serious consequences. In such systems, duplex tubing is recommended, with steel for the ammonia side and a copper-base alloy on salt water side.

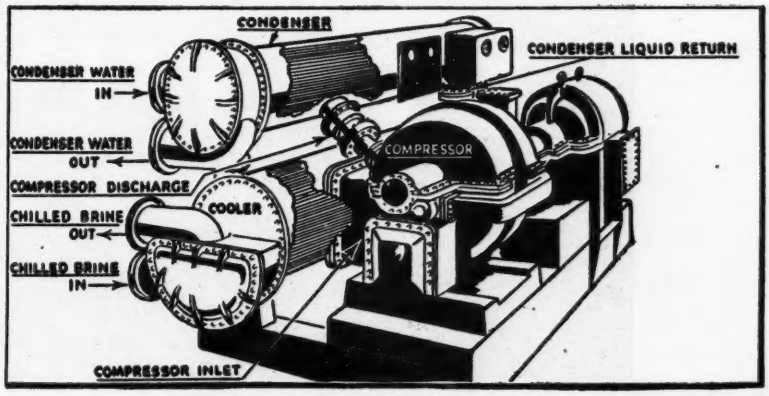
For moisture-free refrigerants of the Freon type, standard copper-base condenser tube alloys are satisfactory.

Bridgeport Copper Tubing

Copper tubing is very useful in air conditioning and for general piping. It does not rust. Solder type and brazed type connectors withstand vibration and do not loosen up as easily as threaded fittings. Installation is simplified by its light weight, ease of bending, solder type fittings (brazed with silfos solder when used for refrigeration gases), and the convenient coils in which it comes.

Condenser Tube Manual

Bridgeport's Condenser Tube Manual contains specifications for modern condenser tube alloys, corrosion research data, facts about duplex tubing and copper tubing plus other important information. Be sure to write for your copy.



Typical "Freon" refrigeration unit for ships

Note: Bridgeport products are supplied in accordance with existing priority regulations.

BRIDGEPORT BRASS

BRIDGEPORT BRASS COMPANY, BRIDGEPORT 2, CONN.

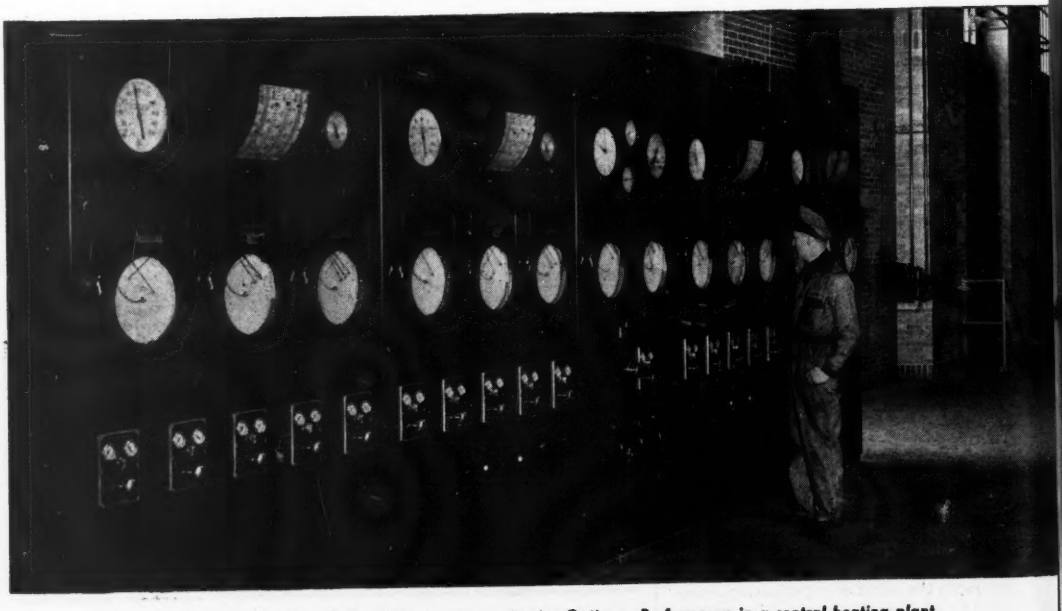
ARMY E NAVY

BRASS

ESTABLISHED 1865

HOW DOES YOUR BOILER PLANT RATE ON *THESE* POINTS?

1. Continuity of service.
2. Evaporation ratio.
3. Safety of operation.
4. Peak steaming capacity.
5. Utilization of available manpower.



This Bailey Boiler Control Panel continuously maintains Optimum Performance in a central heating plant.

BAILEY METER CONTROL

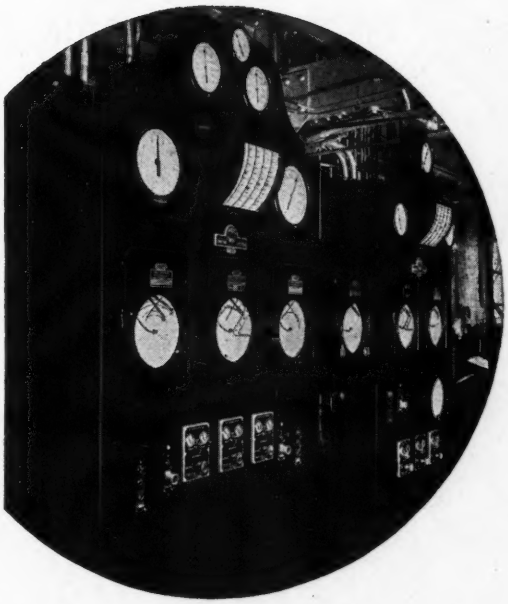
BOILER METERS • MULTI-POINTER GAGES • FLUID METERS • RECORDERS • SUPERHEA

★ Optimum performance may be secured on all these counts by applying engineered instrumentation in the form of Bailey Boiler Meters and Control.

Bailey Boiler Meters and Control are specified and applied to the individual requirements of each plant. Bailey engineering service starts with the selection of equipment and continues through the design, construction, calibration, installation, and final adjustment on the job.

Engineering work in the user's plant is done by Bailey Field Engineers, who have been thoroughly trained in combustion and automatic control practice. These engineers are stationed in over thirty industrial areas throughout the United States and Canada for the purpose of rendering prompt "on the spot" engineering service without undue traveling expense.

The Bailey Engineer in your community has a background of combustion engineering "know-how" which has been accumulated through years of service. He has at his command the results of thousands of tests on boiler installations covering a wide range of fuels, furnaces, and fuel burning equipment. He has more to offer than meters and controllers. He is primarily interested in helping you to secure optimum operating conditions in your plant. G-24

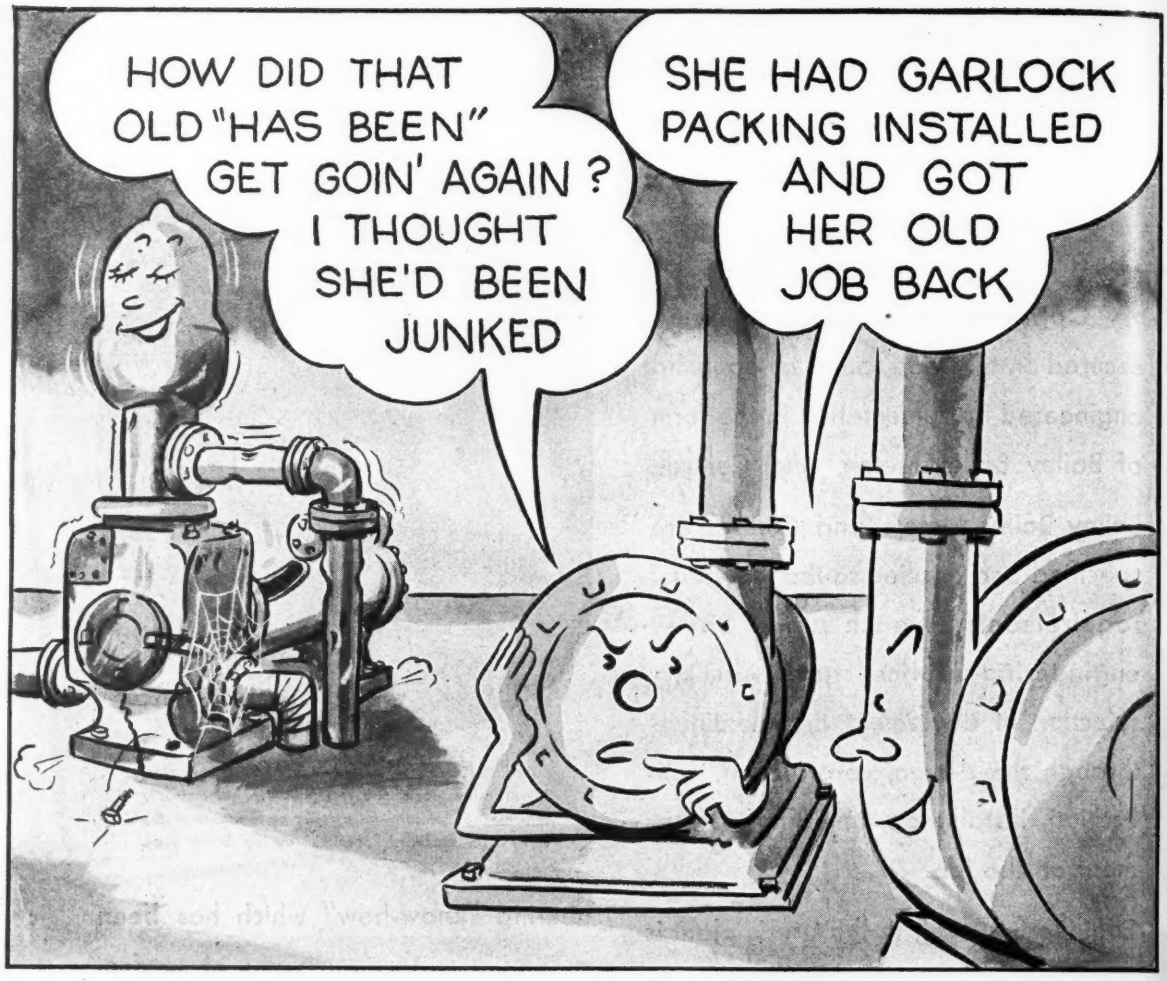


Installation of Bailey Boiler Meters and Boiler Control in an Eastern paper mill. This equipment automatically functions to maintain daily boiler performance at the same high standards obtained during boiler tests.

BAILEY METER COMPANY
1040 IVANHOE ROAD, CLEVELAND 10, OHIO
Bailey Meter Company Limited, Montreal, Canada

The Complete Combustion Control System

CONTROL • DESUPERHEAT CONTROL • COMBUSTION CONTROL • FEED WATER CONTROL


HOW DID THAT OLD "HAS BEEN" GET GOIN' AGAIN ? I THOUGHT SHE'D BEEN JUNKED
SHE HAD GARLOCK PACKING INSTALLED AND GOT HER OLD JOB BACK

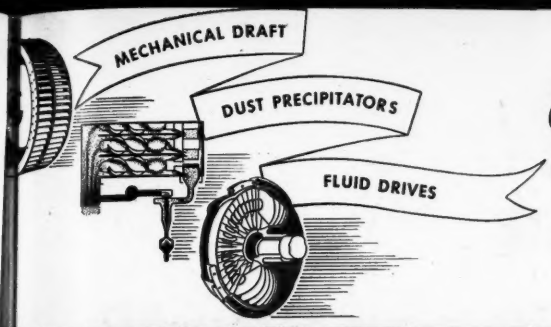
CHEVRON Packing

Yes, Garlock CHEVRON automatic action packing has proved itself on thousands of applications in general industry throughout the country. The unique hinge-like, cross-sectional design allows the packing to expand and contract—*the greater the pressure, the tighter it packs.* You can always depend on CHEVRON for superior performance.

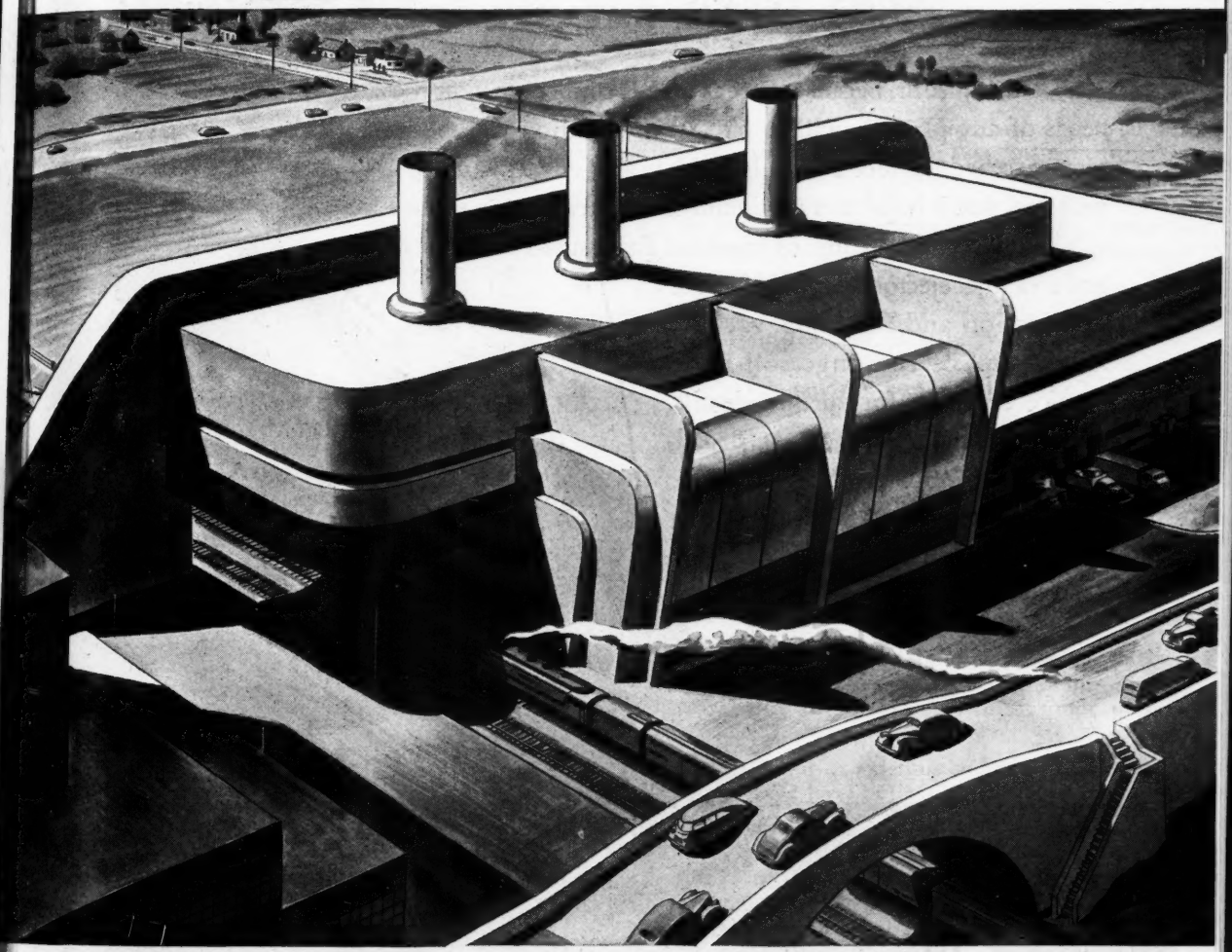
THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK

In Canada: The Garlock Packing Company of Canada Limited, Montreal, Que.

Garlock



You can buy all 3 from A.B.C.



WHETHER YOU BUILD A NEW PLANT or modernize your present one, you appreciate the value of undivided responsibility in your purchase of equipment . . . American Blower Mechanical Draft Fans are widely used in many of the leading power plants. American Blower Fluid Drives improve overall power plant efficiency and provide stepless variable speed fan control for this equipment. American Blower ST Dust Precipitators do away with the fly ash nuisance and definitely reduce fan maintenance . . . Yes, and you can buy all 3 from the same representative of ABC.

HOW TO SOLVE YOUR FLY ASH PROBLEMS. The photograph, on right, shows a part of our modern Dust Testing Laboratory. In the last 20 years, we have run tests on more than 4100 distinctly different materials. Here, complete equipment is available for microscopic investigations, screen analyses and collector performance. American Blower is the world's oldest and largest manufacturer of dry type dust precipitators. We have the largest facilities in the industry, and every precipitator we sell is built entirely in our own plants.

AMERICAN BLOWER

AMERICAN BLOWER CORPORATION, DETROIT, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO

Division of American Radiator & Standard Sanitary Corporation

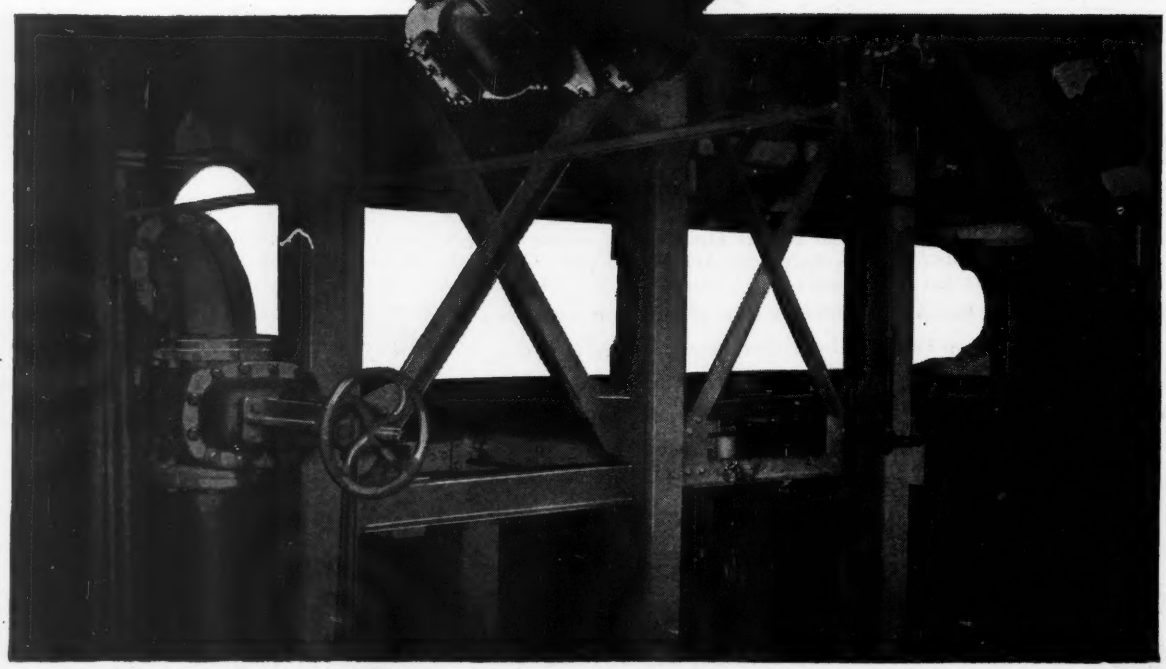
"This CONDENSER will just fit in our Plant"

Yes, it will just fit, because there is an I-R condenser to fit the needs of any plant. It will fit into your operation and maintenance schedules too. You will find it highly efficient and you will find that it requires a minimum of maintenance attention.

There is a complete line of Ingersoll-Rand steam condensers and steam-jet ejectors for prime mover application and for other vacuum services. Ask the Ingersoll-Rand service engineer for further details. Ingersoll-Rand Company, 11 Broadway, New York 4, N. Y.

Ingersoll-Rand

4-509



Now . . .

MORE ACCURATE READINGS OF BOILER WATER LEVELS

"Positive as the Law of Gravity"

The Yarway Remote Liquid Level Indicator offers you this on a brightly-lighted scale right on your instrument panel or at any other convenient location. No more guessing at hard-to-see gages. No more risk of serious damage to equipment due to inaccurate water level readings. *Now double-check your overhead gage readings with this Yarway Eye-level Instrument.*

Its accuracy and dependability are "positive as the law of gravity" for this instrument literally "weighs" the difference between a constant column of water and the varying level in boiler drum and indicates the difference by pointer movement over a calibrated scale.

Indications are instant. The luminous pointer follows the water level constantly—is always visible, even in complete darkness. The indicating mechanism is never under pressure—is frictionless—is perfectly balanced on jewelled bearings. *There are no stuffing boxes.* Indicating and actuating mechanisms are completely separated, but operate simultaneously through a powerful, permanent magnet transmission.

Accelerated endurance tests in the Yarway Steam Laboratory have duplicated 50 years of normal boiler service without need for repair, replacement of a single part or recalibration.

Easily installed on new or existing boilers or other equipment requiring liquid level indication.

Suitable for pressures up to 1500 lb. Hundreds have been purchased and repeat orders indicate enthusiastic user satisfaction. Write for Bulletin WG-1820.

YARNALL- WARING CO. 114 Mermaid Ave., Phila. 18, Pa.

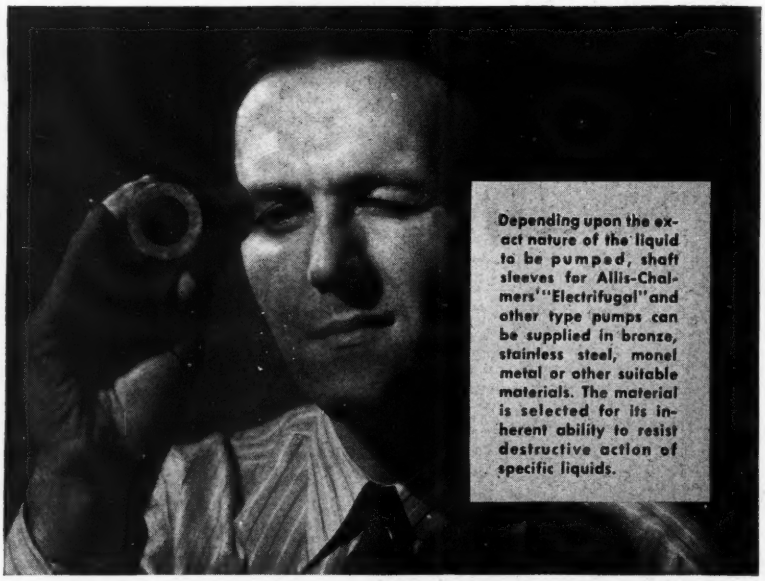
Above: The Yarway Remote Liquid Level Indicator for mounting on wall or building column.

Below: Two Yarway Liquid Level Indicators mounted on instrument panel of prominent high pressure New Jersey Utility.

YARWAY REMOTE LIQUID LEVEL INDICATOR

[PUMP TIPS FROM ALLIS-CHALMERS — ONE IN A SERIES]

How to make SLEEVES Last Longer . . .



Depending upon the exact nature of the liquid to be pumped, shaft sleeves for Allis-Chalmers' "Electrifugal" and other type pumps can be supplied in bronze, stainless steel, monel metal or other suitable materials. The material is selected for its inherent ability to resist destructive action of specific liquids.

AS WITH MANY pump troubles, excessive sleeve wear is apt to trace back to misalignment of pump and motor. For when shaft is deflected, sleeve is apt to wobble within the packing — accelerating friction and wear.

So serious is this problem of misalignment, that Allis-Chalmers engineers were led to develop, for many applications, the famous "Electrifugal" pump — in which both the motor and pump impeller are mounted on one shaft and in one frame.

In such a pump the elements cannot get out of line — and danger of excessive sleeve wear is minimized. However, many pumps in use today are separate from their driving motors — and the coupling flanges must be carefully aligned . . . and *kept* in alignment!

Here are other ways to extend sleeve life:

▶ Don't draw stuffing box gland too tightly . . . excessive pressure will wear shaft sleeves unduly.

▶ Never pump a liquid for which your pump was not designed. Sleeves are able to withstand corrosive effects of some but not necessarily all liquids. When in doubt over safety of changing pump application, check with your manufacturer.

▶ Generally a thin stream of liquid being pumped serves as a water seal between packing and sleeve. If it is dirty or abrasive, a separate supply of sealing liquid should be obtained. And it should reach the sleeve in a steady supply. Be careful water seal piping isn't plugged — or lantern ring displaced.

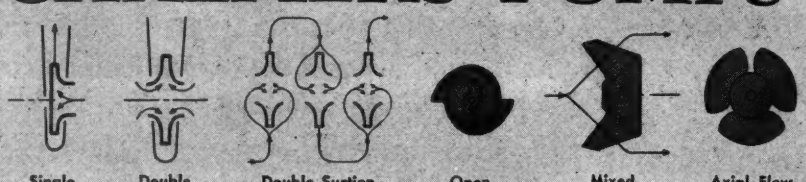
▶ Send for your *free* copy of Allis-Chalmers' "Handbook for Wartime Care of Centrifugal pumps". This valuable booklet applies to *all* makes of pumps. ALLIS-CHALMERS MFG. CO., MILWAUKEE 1, WIS.

♪ *Tune in the Boston Symphony, Blue Network, every Sat. Eve.*

A 1708

ALLIS-CHALMERS PUMPS

Allis-Chalmers builds all types and variations of pumps shown at right. Capacities from 10 to 150,000 gpm—heads to 2500 lbs.



What to do about Rust?

Make this Test

Immerse any rusty nail in a small quantity of Cities Service Rust Remover. If badly rusted, allow to remain for several minutes. You can actually see the rust dissolve.

See the Results

Remove nail and wipe dry with cloth or tissue. Note the complete absence of rust and the way the original surface reappears.

CITIES SERVICE RUST REMOVER has been tested for four years throughout a small, highly industrialized area in the East, where it has earned a unique reputation for performance. RUST REMOVER is a clean, clear liquid, practically odorless, non-inflammable, easily applied, and harmless to handle by those not allergic to specific chemicals. It is fast-acting, and, although heating somewhat accelerates results, general application is recommended at normal temperature (60°-90°F.). RUST REMOVER is effective on chromium, copper, aluminum, steel and iron.

5 Big Advantages

1. Non-Inflammable
2. Harmless to Normal Skin
3. Makes Metals Chemically Clean
4. Removes Rust by Chemical Action
5. Free from Muriatic, Sulphuric, Nitric and Oxalic Acids or Cyanide.

See a Free Demonstration of Rust Remover on Your Own Equipment.

(Available only in Cities Service marketing territory East of the Rockies.)

MAIL THIS COUPON TODAY!

CITIES SERVICE OIL COMPANY
Room 196
Sixty Wall Tower, New York 5, New York

Gentlemen: I'd like to test RUST REMOVER on my own equipment FREE OF CHARGE. Send me details.

Name.....

Company.....

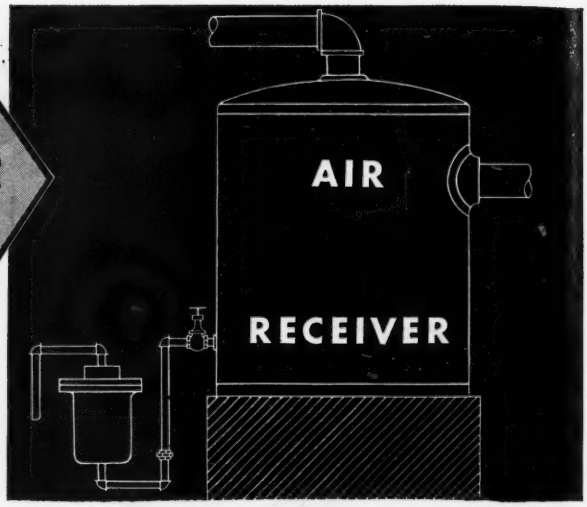
Address.....

City..... State.....

CITIES SERVICE OIL COMPANY
NEW YORK · CHICAGO

IN THE SOUTH
ARKANSAS FUEL OIL COMPANY
SHREVEPORT, LA.

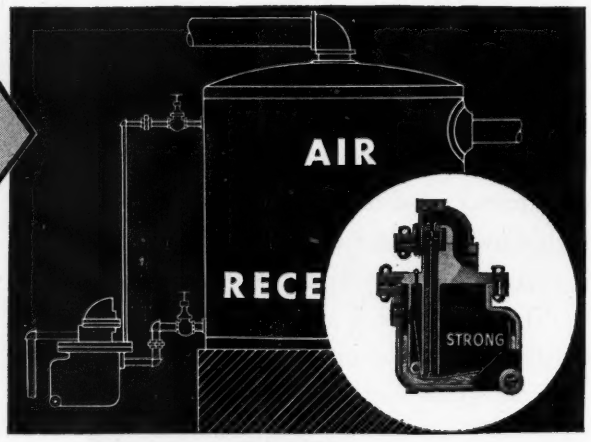
PROBLEM:
PREVENT WASTE OF AIR
(or other incondensible gas)
IN DRAINING SYSTEM



Using inverted bucket traps: This type of trap is ideal for steam service, particularly where it is necessary to remove air as well as condensate. The fact that these traps do discharge air, makes them undesirable for systems where no air or other non-condensible gas should be wasted.

How Would YOU DO it?

Here's STRONG'S Suggestion



Using open bucket trap with equalizer between trap and receiver or line being drained. No gas is lost when trap discharges, because liquid in discharge tube forms liquid seal between gas (or air) and discharge valve. Strong open bucket traps available for use with water, ammonia, brine, gasoline, oil, etc.

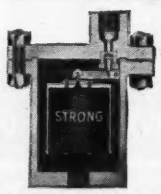
Both KNOWING the Answer — and HAVING It!

The fact that the Strong line includes open *and* inverted bucket traps—as well as other types—means that our engineers can look for the best answer to your problem, knowing that the complete line of Strong steam specialties includes the equipment that answer calls for.

Their suggestions are backed by long experience with the complete Strong line, which includes open and inverted bucket, closed float, float-and-thermostatic (blast) traps, etc.—forged, fabricated (welded), cast and semisteel construction. Send your problems to Strong, Carlisle & Hammond Company, Cleveland 13, Ohio.

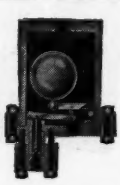
STRONG, CARLISLE & HAMMOND COMPANY
Cleveland 13, Ohio

OTHER
STRONG
STEAM SPECIALTIES

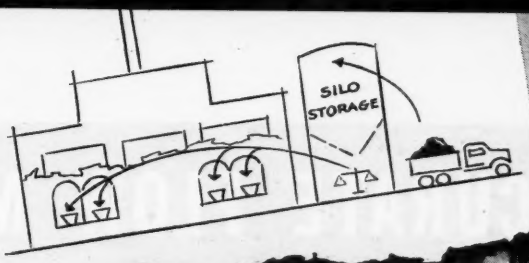


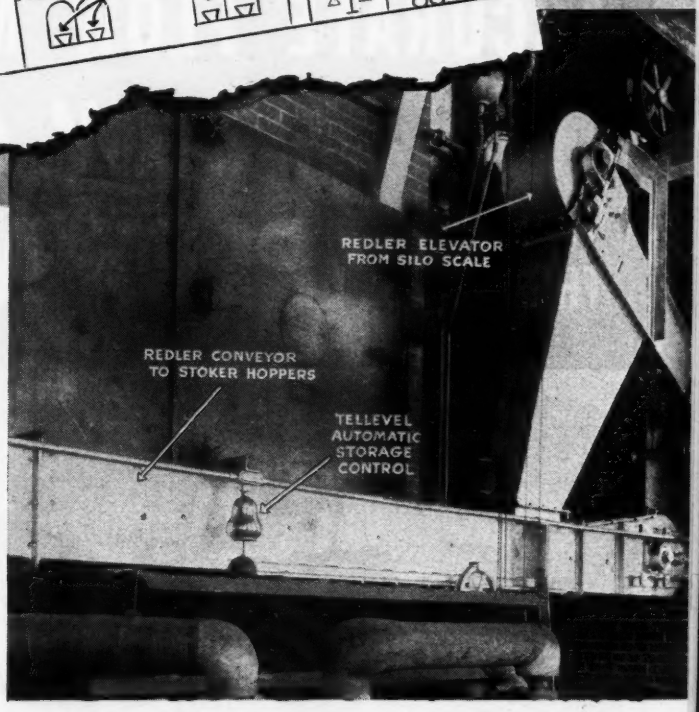
Welded Steel Traps

Reducing Valves


Float Traps

The Problem — a modern system for
(1) Storing coal
(2) Reclaiming in weighed amounts for delivery direct to stoker hoppers





THIS AUTOMATIC, HIGHLY EFFICIENT SYSTEM IS THE S-A ANSWER

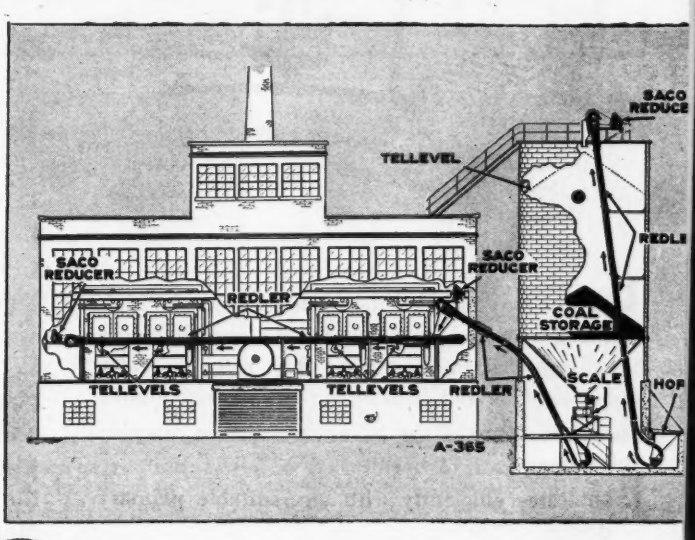
• From trucks to storage silo to scale to stoker hoppers—those are the steps required to handle coal at this power plant. Formerly served by open type, space wasting equipment, three REDLERS now accomplish all operations with greatly increased efficiency.

As shown in illustrations, one REDLER Elevator and two Conveyors handle coal from trucks to boilers. Benefits made possible by this engineered system are automatic weighing of measured amounts of coal from silo . . . automatic feeding of four different stoker hoppers . . . complete absence of dust since coal is enclosed in sealed casing at every handling stage . . . extreme compactness and elimination of open bunkers and bulky larry.

Let S-A engineers help you achieve comparable advantages at your plant. Write us today.

Above: View at junction of REDLER Conveyors at first stoker hopper.

Below: Diagram indicates simplicity and compactness of closed REDLER system. Key unit is the long, horizontal conveyor running full length of boiler room directly over stoker hoppers, feeding any one or all of them by gates. S-A TELLEVEL regulates coal flow and automatically operates conveyor system.



STEPHEN S-A ADAMSON MFG. CO.

515 RIDGEWAY AVENUE, AURORA, ILLINOIS — LOS ANGELES, CALIF. ★ BELLEVILLE, ONT.

Designers and Manufacturers of All Types of

BULK MATERIAL HANDLING EQUIPMENT

ACCURATE FLOW MEASUREMENT at LOW COST THE SIMPLEX MS METER

This low cost Simplex instrument meets the high standards for accuracy, sensitivity and dependability required in measuring flow rates in water and sewage, as well as in power and process plants. These are some of the advantages of the Simplex MS Meter:

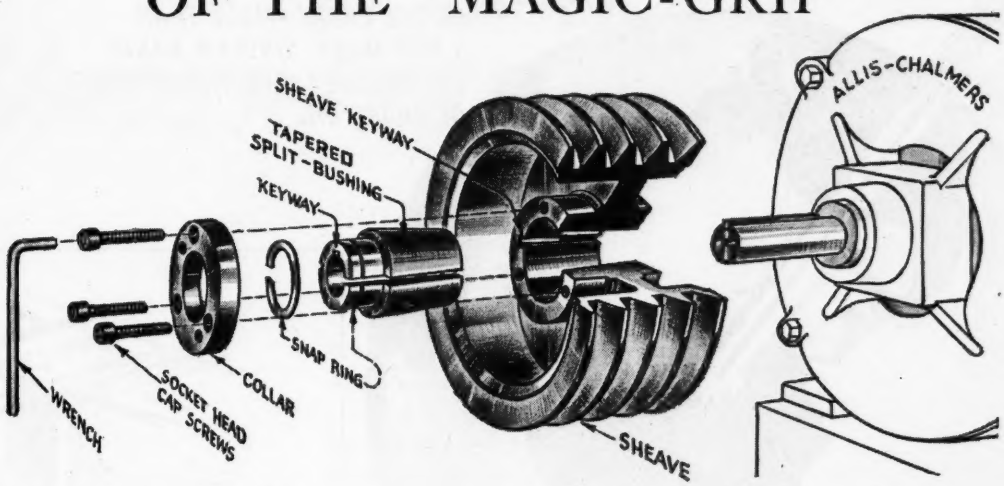
1. Operates efficiently with any suitable primary device.
2. Is installed and maintained economically.
3. Rugged, trouble-free construction.
4. Accuracy over entire flow range.
5. Simplex bell-shaped float which translates the half power of the differential into uniform graduations of chart and dial.
6. Direct reading totalizer of the 7 digit type.

Complete data is now available in Bulletin 350 — straight-forward, factual information with drawings, charts, and test data. Write for your copy today — specify the Simplex MS Meter in tomorrow's planning.

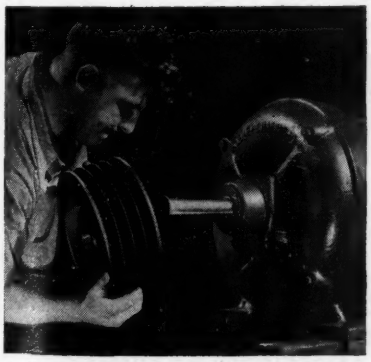
SIMPLEX VALVE & METER CO.
6783 UPLAND STREET, PHILADELPHIA 42, PENNA.

Here's the Secret

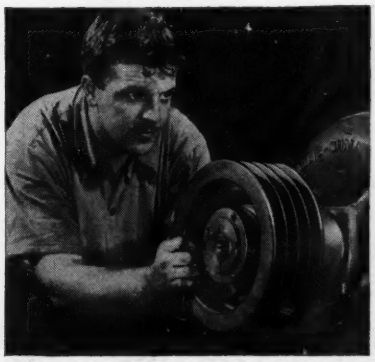
OF THE "MAGIC-GRIP"



Exploded view shows why Allis-Chalmers' new "Magic-Grip" Sheave goes on *as a unit in 3 easy steps.* It's the fastest mounting sheave on the market—at no extra cost.



1 Place sheave on shaft. Slides on smoothly because clearance is provided by expanded bushing. There's *no* hammering — *no* forcing! Complete sheave and bushing unit comes intact—ready for quick, easy mounting.



2 Slide to desired position. Sliding easily, sheave can be placed *exactly* according to straight-edge . . . giving you true alignment with resulting smooth performance. A minimum of time is required.

3 Tighten three capscrews — and it's ready to go! Entire sheave is locked securely to shaft and *grips like magic!* No set screws to damage shaft. Send for Bulletin B6310. Allis-Chalmers, Milwaukee 1, Wis.

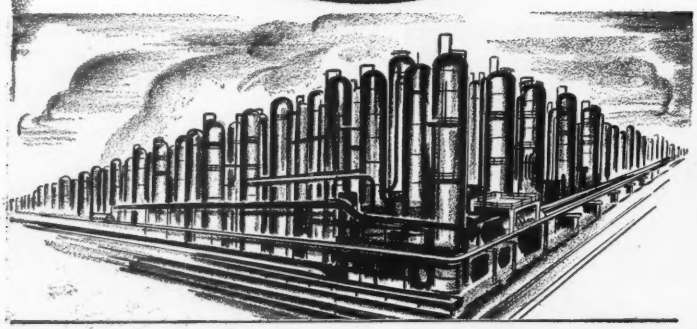
A 1764

Allis-Chalmers Texrope

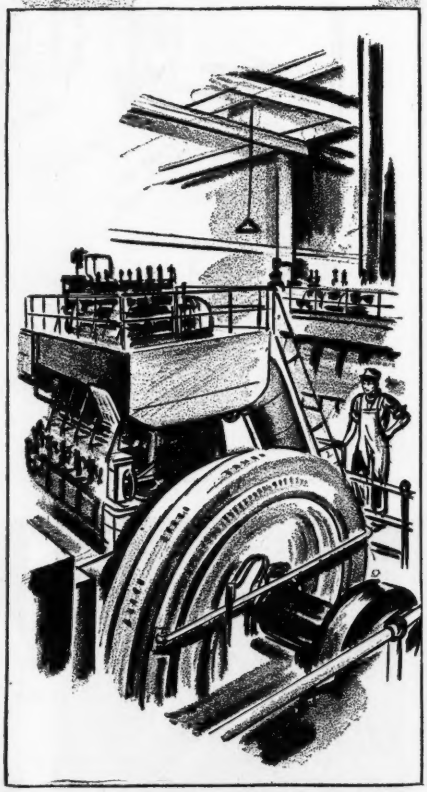
"MAGIC-GRIP" SHEAVES

Do you know that . . .

SINCLAIR PRODUCING OIL WELLS IF PLACED END UNDER END WOULD REACH TO THE CENTER OF THE EARTH—MORE THAN 3,500 MILES. SINCLAIR RANKS AMONG THE LARGEST PRODUCERS OF CRUDE OIL.



SINCLAIR'S 10 GREAT REFINERIES, IF MASSED TOGETHER, WOULD COVER AN AREA OF 2,300 ACRES —THE APPROXIMATE AREA OF A CITY OF 100,000 POPULATION. THESE REFINERIES MANUFACTURE A FULL LINE OF QUALITY PETROLEUM PRODUCTS FOR ALL MILITARY, INDUSTRIAL AND GENERAL USES.



A CLEANER DIESEL ENGINE IS MADE POSSIBLE BY THE DETERGENT CHARACTERISTICS OF SINCLAIR TEN-OL 200. THIS IS ONE OF SEVERAL SINCLAIR OILS PREPARED SPECIFICALLY FOR BETTER DIESEL LUBRICATION.

SINCLAIR IS EQUIPPED TO SERVE YOU BETTER!

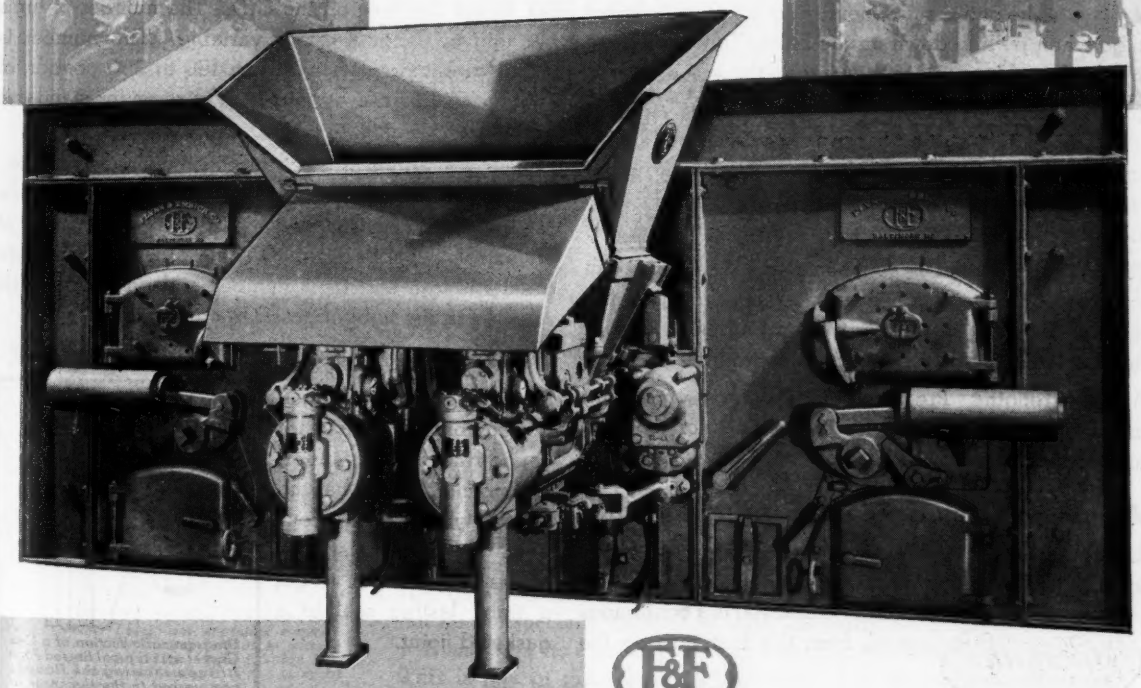
FOR FULL INFORMATION OR LUBRICATION COUNSEL WRITE SINCLAIR REFINING COMPANY, 630 FIFTH AVENUE, NEW YORK 20, N. Y.

SERVING OVER 700,000
BOILER HORSEPOWER

"F & E"
UNDERFEED STOKERS

There is an "F & E" Underfeed Stoker to meet your requirements—whether they be 1000 lbs. of steam per hour or 40,000!

See the "F & E" representative in your locality, your own consulting engineer or write manufacturer for information that tells WHY and HOW "F & E" Underfeed Stokers increase output of boilers, reduce fuel bills, provide dependable operation, increase efficiency.



THE ONLY STOKER
WITH THIS COMBINATION OF ENGINEERED FEATURES
1-Choice of Electro-Hydraulic or Steam Ram Drive; 2-Internal Timer Governor; 3-Sliding Bottom Retort; 4-Renewable Ram Case Liner; 5-Exterior Fuel Bed Adjuster; 6-High Efficiency Tuyeres

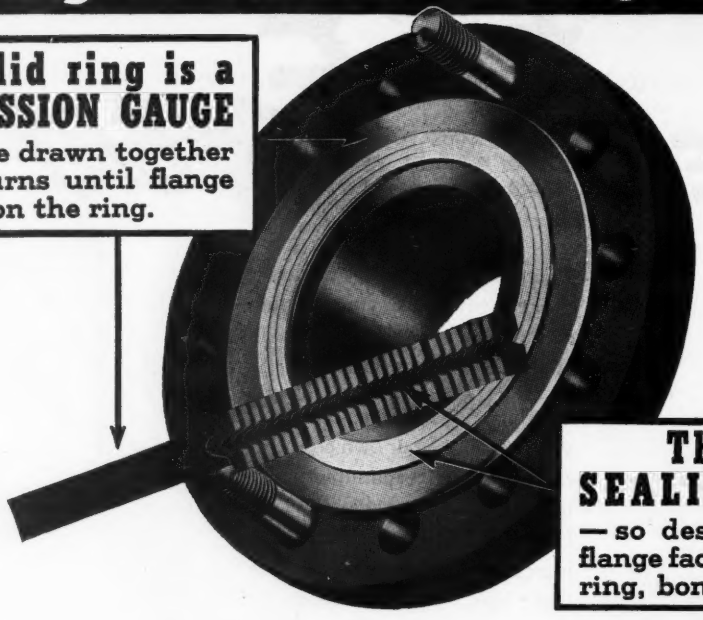
F&E

FLYNN & EMRICH CO.
Established 1842
HOLLIDAY & SARATOGA STREETS, BALTIMORE 2, MARYLAND
Representatives in Principal Cities

FLEXITALLIC C-G GASKETS

for High-Pressure Flanged Joints

This solid ring is a COMPRESSION GAUGE
Flanges are drawn together by bolt-turns until flange faces rest on the ring.



This is the SEALING MEMBER
— so designed that when flange faces are drawn to the ring, bonding load is right.

The outer, solid metal ring tells you how far to go when pulling down on the bolts. You don't have to calculate. Just pull to the ring and stop.

You don't have all the worry about the sealing member being properly centered. The ring fits the bolt circle and the bolts guide the sealing member to the right position. They hold it there while the joint is being assembled.

The sealing member is so made that it has density in exact relation to *your* pressure. When you pull the flanges down to the ring, you set up a gasket barrier that has ample strength for *your* conditions.

Ample strength? Precisely. The density of sealing metal is neither too great for the bolting nor too little to hold the confined fluid.

Adjusting Density of the Sealing Member

In the sectional view above, you see stacked metal looking like laminations. In the structure of the sealing member, this metal is a continuous spiral, from the first turn on the I.D. to the last turn on the O.D. The number of turns per unit of flange-width is variable. The number is of one order for pressures from 150 to 300 pounds, of another order for 400 pounds, and so on for standards up to 2500 pounds.

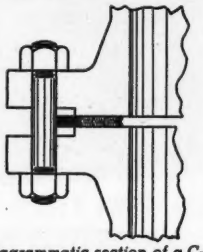
Density is modified also by winding metal turns together, leaving out the spacing material. Butted turns can be readily identified, in the sectional view, not only at the extremes but in between. These butted turns have great strength and their number and position can be selected in the light of pressure conditions.

"Flexitallic" Reg. U.S. Pat. Office

Representatives in Principal Cities

There's Something TO This Gasket Art

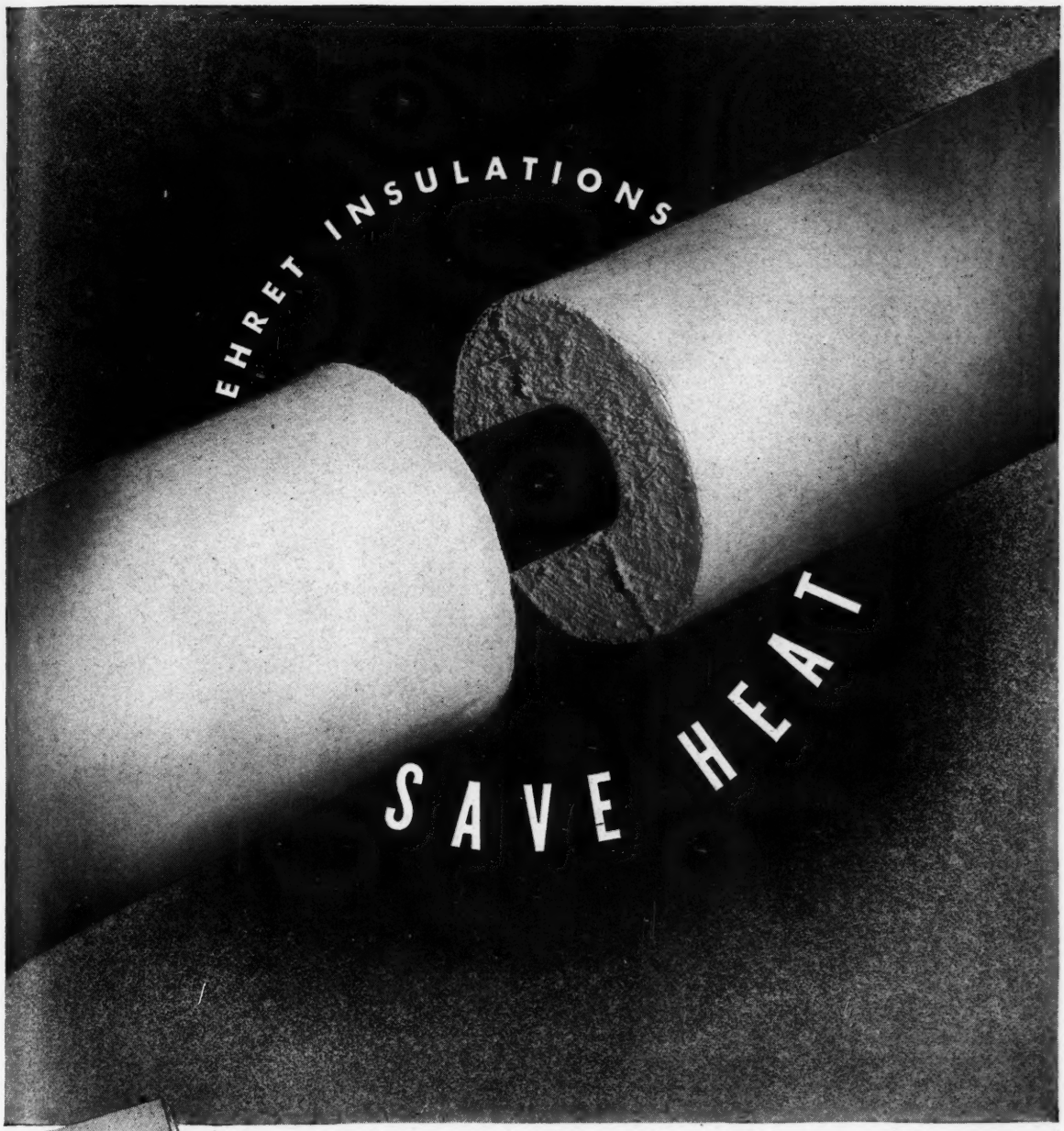
It seems a simple thing—this combination of a solid, gauge-ring and an inner, sealing member. It has the simplicity of saving your time. It is the simplest and easiest way for you to get a tight, lasting seal in a gasketed joint.

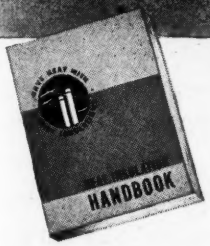


Diagrammatic section of a C-G Gasket with typical Raised Face fittings showing the flanges compressed to the thickness of the solid metal member.

FLEXITALLIC GASKET CO., 8th and Bailey Streets, Camden, N. J.

Originators of Spiral Wound Construction





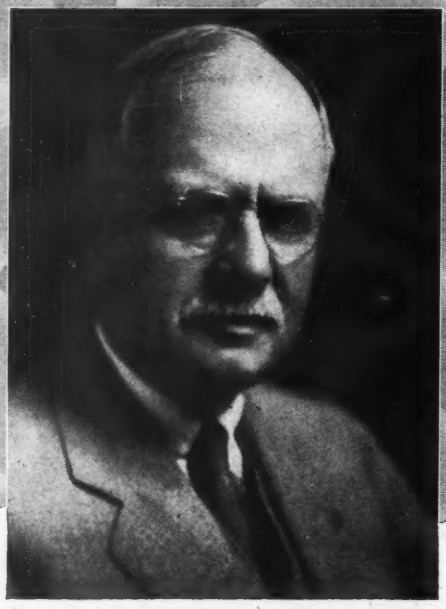
EHRET'S 85% MAGNESIA and many other Ehret heat insulating materials are fully treated, both as to selection and application, in the 176-page Heat Insulation Handbook. Write today for your copy.

More than half a century ago, when steam pipes were "covered" with mixtures of sawdust or old rope and plaster of Paris, there was little realization of the true value of insulation. How times have changed!

The power engineer of today is not only fully aware of the necessity of using insulations that are highly efficient when applied, but he is especially concerned with choosing an insulation that will *maintain* its efficiency, year after year, for its entire service life. This is one of the reasons why Ehret's 85% Magnesia has long been specified for temperatures up to 600° F. and Ehret's Enduro up to 2000° F. In fact, the demand for these two Ehret Insulations is greater today than ever before.

EHRET MAGNESIA MANUFACTURING CO. • VALLEY FORGE • PENNSYLVANIA

"Our Business, Like Yours, ...is *Different!*"



A few comments based on the first 50 years of the JAMES G. BIDDLE COMPANY

BUSINESSES, like people, usually have distinct, individual personalities. The smaller the business, the more clearly it will reflect the character of the man who built it.

In 1895, when the electrical industry was in its infancy, James G. Biddle went into business as a manufacturer's agent, selling electrical measuring instruments and scientific apparatus. One of his basic aims in the conduct of the business was to be more than a mere source of supply. He decided to provide a service that was outstanding by reason of its alert, interested, personal character. This aim has never been changed by Mr. Biddle or his associates during the last half century. It will continue to be an important factor in the policies of the James G. Biddle Company in the years to come. We are committed to this.

•

In celebration of our 50th anniversary, we have prepared a brief booklet entitled "Report at Mid-Century." It touches upon interesting points regarding the growth and advancements of the electrical field in general and our business in particular. We would be pleased to send you a copy upon request.

JAMES G. BIDDLE CO. • 1211-13 ARCH STREET • PHILADELPHIA 7, PENNA.

"MEGGER"* INSULATION TESTERS, GROUND TESTERS AND OHMMETERS • "FRAHM" TACHOMETERS AND FREQUENCY METERS • "JAGABI" RHEOSTATS • INDICATING HAND TACHOMETERS • SCIENTIFIC APPARATUS

*TRADE MARK REG. U. S. PAT. OFF.

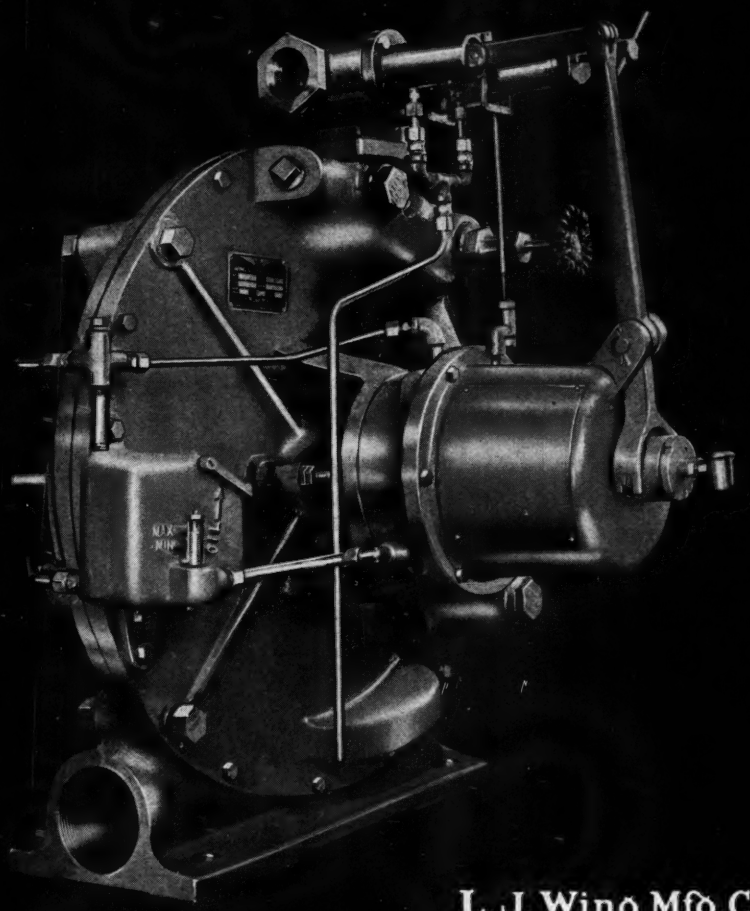
OPERATING RANGES

	Standard	High Pressure
Maximum B. H. P.	100	250
Max. Steam Temp.	525° F.	750° F.
Max. Pressure	275 lbs.	600 lbs.
Back Pressure up to	50 lbs.	50 lbs.
Speeds, up to	4000 RPM	4000 RPM

USES

PRIME MOVERS FOR MIXERS, MARINE GEAR PUMPS, FANS, STOKERS, WINCHES, GENERATORS, COMPRESSORS

Write For Bulletin SW-1 "Wing Forced Draft Blowers and Auxiliary Turbines"

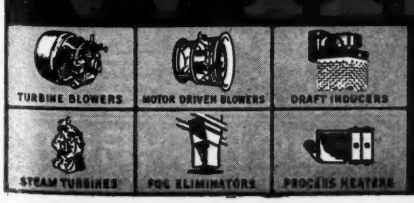


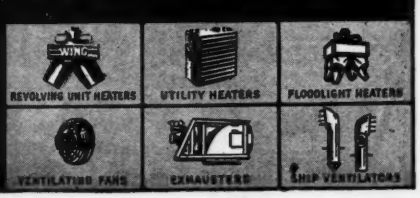
L. J. Wing Mfg. Co.

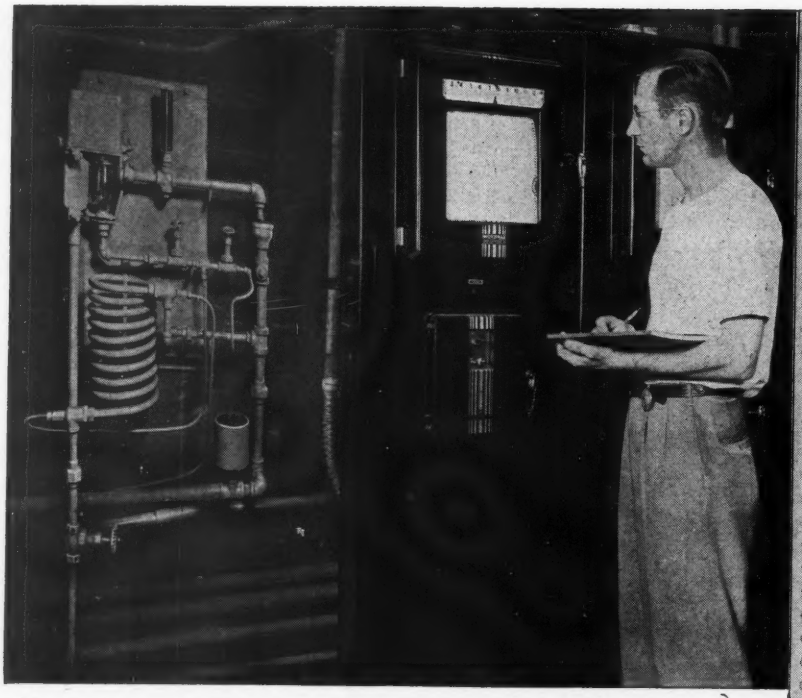
154 W. 14th St., New York 11, N. Y.

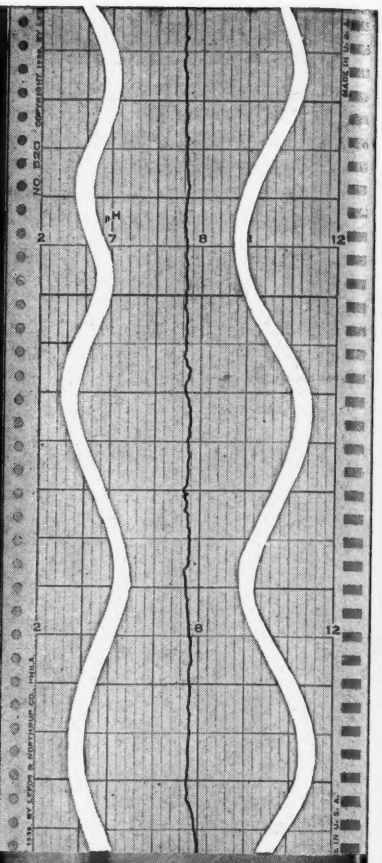
Factories: Newark, N. J. and Montreal, Canada

Wing TURBINES









Micromax pH Control, feedwater plant, Wyandotte Chemicals, Inc., Wyandotte, Mich. Right, typical pH chart of finished water in a holding tank.

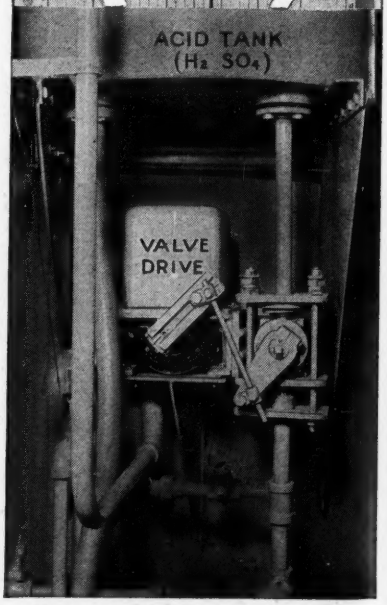
Wyandotte Plant Holds pH to ±0.2 With Micromax Recording Controller

Faced with the problem of reducing the pH of feedwater from 10.1 to 7.9, Wyandotte Chemicals, Inc., use an L&N Micromax automatic Recording Controller to do the job. The pH is reduced — and held within a band only ±0.2 wide.

The pH of the raw water, from the Detroit River, is 7.5. The water treating cycle begins with a lime soda softening, then phosphate softening, after which the water is deaerated and filtered. Following filtration, the pH measures 10.1. To reduce it to 7.9, sulfuric acid is added by means of the Micromax Electric Control valve, shown at the right. Finished water, when measured at the end of the treating process, is within ±0.2 of the ideal. Valuable man hours are saved that would be expended in a manual method of control, and waste of acid is eliminated. The Micromax Controller also supplies a continuous graphical record, on a chart almost ten inches wide. It is large and bold enough to be read quickly and accurately by any workman.

Corrosion worries don't exist. The closeness of control at the desired pH value prevents corrosion of piping and simplifies the handling of other factors which are influenced by the pH of the feedwater.

Further details of L&N Micromax automatic pH Recording Controllers are available in Catalog N-96(1), which will be sent on request. If you have a specific pH problem in mind, and will outline it, an L&N engineer will be glad to send further information.



Micromax Electric Control valve drive on reagent sulfuric acid.

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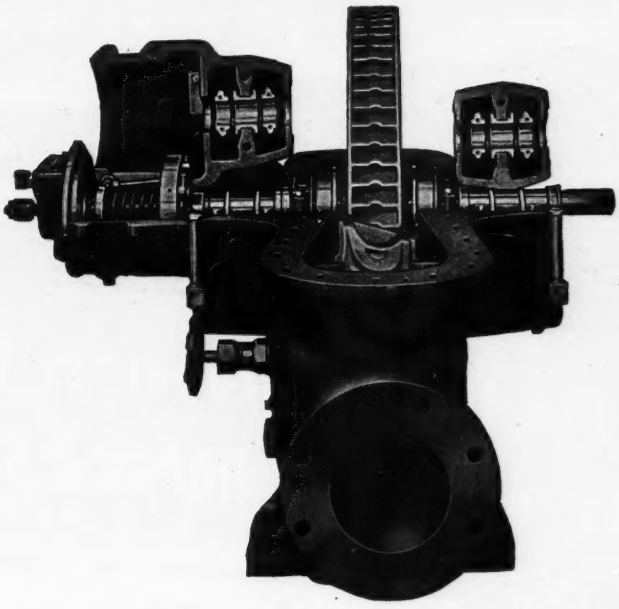

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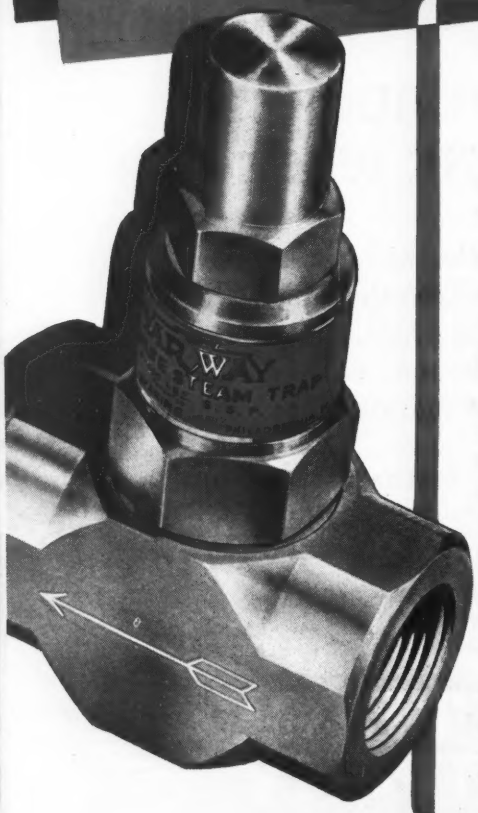

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WHAT LEADERS SAY

Opportunity for Discussion

By WILLIAM BENTON

THE FIRST LAW of Conversation, says an economist friend of mine, is this: Cheap Talk tends to drive out Good Talk.

If I believed this paraphrase of Gresham's famous dictum about money, I would despair of democracy. Democracy proceeds by endless conversation, discussion and debate. The better the discussion and debate, the less the danger of rule by force, demagoguery and reaction.

I do not agree with my disillusioned friend—despite his evidence about the circus element in our political campaigns—because I have been hearing too much good discussion. Through my participation in the research meetings of the Committee for Economic Development, I know how good a small-group discussion can be. Through my interest in the University of Chicago Round Table, I know that five to ten million listeners will tune in on good discussion among experts. The country is readier for honest, fair and informed argument than the politicians believe it to be.

The great opportunity for pro and con discussion does not lie in increasing the sheer *volume* of public discussion, desirable as that may be. The great challenge is to raise the *quality* of discussion. By temperament and by political organization, America has always been one of the "discussingest" nations on earth. We have only to look at Congress and other elected assemblies; at the columns of newspapers and magazines; at the courts, the colleges, the public forums; in homes, on street corners, around the cracker barrel. Public questions are debated within business concerns, labor unions and farm organizations. More recently radio has become the great instrument of public discussion, through such national programs as the Town Meeting, People's Platform, the University of Chicago Round Table, and through countless similar programs on local stations.

What makes discussion good? Here are four points which help make it good:

1. Good discussion must not shrink from or skirt fundamental issues. I have observed, on our Sunday Round Table, that most social and political questions, however specifically they are phrased, can be resolved only in terms of basic conceptions about the proper relation of the government and the individual; about the proper role of our nation among other nations; and, in both these, in terms of basic judgments as to what is practical at this moment of history.

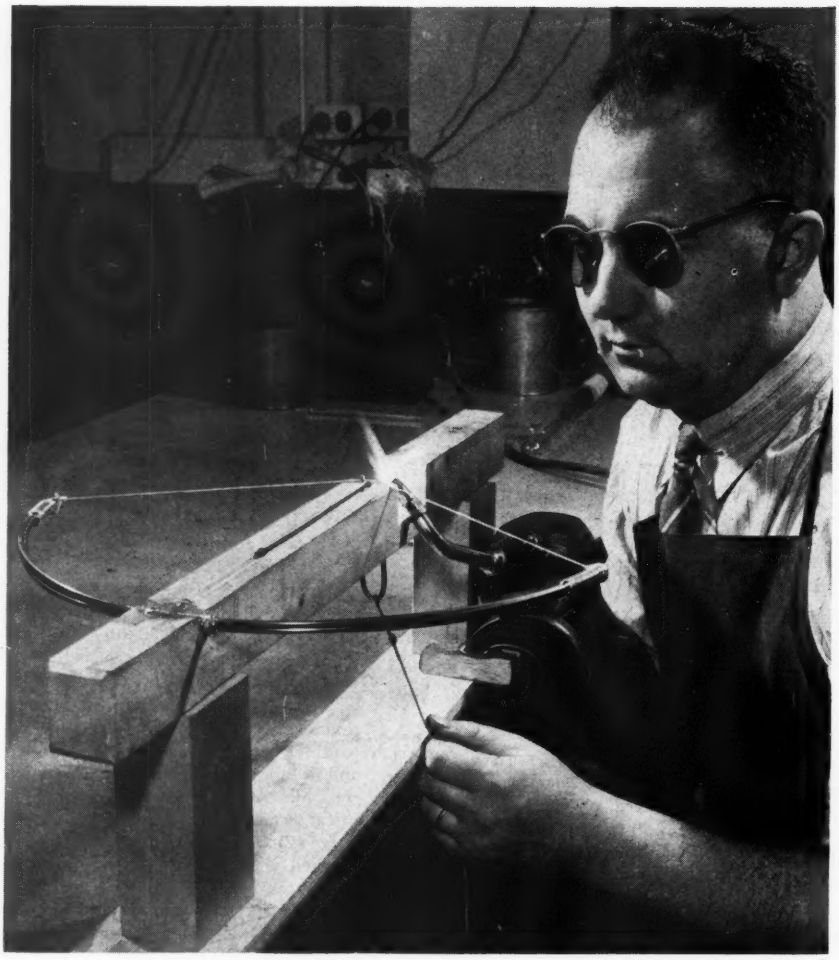
2. Good discussion must be based in part—but only in part—on facts and expert opinion. I do not subscribe to the notion that the modern world is getting too complicated for the intelligent layman to understand. The citizen must learn how to choose among the experts. If issues are presented to him properly, he can make valid judgments even about such questions as the White plan versus the Keynes plan, or the Hansen oversaving theory versus classical economics.

3. Good discussion is more than the effort to achieve compromises among the conflicting selfish interests of pressure groups, although such compromise is often legitimate and necessary. At its root, good discussion must seek to clarify and advance the *common good.*

4. Finally, good discussion must be disciplined, and it must shun the tricks of debate. The discussants and the listeners must know something about the rules of thinking; and the more they know about the development of political thought in the western world, and in our own nation, the better the discussion will be. The first duty of our educational system is to train young people to think straight and for themselves, and to talk and write clearly. These are the objectives of liberal education. Political discussion in this country has seldom reached so high a point as it reached when Madison, Hamilton and Jay wrote "The Federalist Papers," to persuade states to adopt the new Constitution. It is not too much to hope that, if our unprecedented system for mass education will direct itself to liberal education, we may achieve on a mass basis the level of discussion reached by the few in other countries and at other times.

The one thing I most fear is the growth of contempt for talk. That will happen only if Cheap Talk drives out Good Talk. If that happens, then, as a great political scientist has put it, we can blow out the lights and shoot it out in the dark; for when the voice of reason is silenced the rattle of machine guns begins.

WILLIAM BENTON is vice-president of the University of Chicago, vice-chairman of the Board of Trustees of the Committee for Economic Development, which he helped to organize, and board chairman of the Encyclopaedia Britannica and Encyclopaedia Britannica Films. Since resigning as board chairman of the Benton and Bowles advertising agency in 1936, he has devoted himself to education and to economics. This article was prepared exclusively for POWER PLANT ENGINEERING through Business News Service.



A MODERN CROSS-BOW

THE CROSS-BOW, storied weapon of medieval times, is being used by Westinghouse research engineers as a helpmate to one of the most modern of scientific instruments, the electron microscope. Fashioned from tough, flexible steel and mounted on a wooden stock, the cross-bow shoots an arrow that draws out quartz filaments so fine that it would take 60 of them to make the thickness of a human hair. The filaments—1/30,000th of an inch in diameter—are used to measure, or calibrate, the magnifying power of the electron microscope. To make such a very delicate thread, according to Dr. Alois Langer, of the Westinghouse Research Laboratories, requires a high initial burst of speed that "spins out" the quartz while it is in a hot, fluid state and before it has a chance to cool and harden. The cross-bow is about the simplest and most efficient instrument for doing this.

Since the electron microscope magnifies objects many thousands of times, scientists need a very minute "measuring stick" by which to gage its power. A human hair, for example, seen under the electron microscope at its greatest magnification would resemble a cable almost two feet thick. Some of the filaments drawn by the bow are so delicate that they are invisible to the naked eye. They can be seen, however, by holding them against a strong light.

As shown in the photograph, the production of these filaments is simple. The cross-bow is placed in position and a small piece of quartz is attached to the end of the arrow. The quartz is then heated until it is just about to melt. Then the operator pulls the trigger. The arrow darts from the bow at high speed, trailing behind it gossamer-like threads of quartz. Unbroken pieces up to 20 ft in length are not unusual but more often the filaments are dispersed in smaller sections throughout the route the arrow takes.

WITH THE EDITORS

◆ **Marketing Needs Engineering**—Engineers are continuously looking for fields to conquer and thus give outlet for their particular human talents in the economy of the country. Right now many of them see a need for the application of engineering principles to the marketing of materials, agricultural produce and manufactured goods. It is irritating to the analytical mind of the engineer that the things he produces and the materials he requires for production absorb so much of their cost in sales and distribution expenses, for he sees many ways in which handling of goods in commerce could be expedited, and distribution costs reduced.

Of the three links in the chain of the life of materials, i.e., production, distribution and use, the engineer holds practical mastery over two. Engineering principles now known to the profession, however, have not been applied, to the extent they should be, to the problems of distribution.

In his address prepared for presentation before the annual meeting of the ASME, President Robert M. Gates stated that "economies in production have not been matched by economies in distribution. Industry's capacity to produce has not been fully used because the relatively rigid cost of distribution has blocked the channel—limiting effective demand and so checking the flow of production. The productivity we create demands open channels of distribution. Surely engineering techniques need to be applied there. Our obligation includes the whole process."

President Wickenden of Case School of Applied Science evidently had a similar view when he stated in an address to Canadian engineers: "Engineers will find their way into every field where science needs to be practically applied, cost counted, returns predicted and work organized systematically."

From completely outside the engineering field we get the opinion of G. D. Crain, Jr., publisher of "Industrial Marketing" that many of the important executives in management and marketing positions are engineers by training, having received professional training in the principles of engineering with the idea, no doubt, of following careers in which this training would be of primary importance. Yet the demands of industry for management and marketing direction have resulted in their being given positions where they are responsible for marketing and distribution. Mr. Crain has stated that engineering schools have not been as conscious of the probable direction in which their graduates would go as an analysis of alumni titles would suggest and strongly urges that business courses be included in their curricula.

◆ **Distribution in commerce** may be considered as that branch of industry having to do with the delivery of materials from where they are produced to the places where they are used or consumed. The means for making these deliveries are physical and are fundamentally within the realm of the engineering profession; the reasons for distribution are, however, sociological and depend upon human living requirements and desires.

Engineers are in the habit of dealing with tangible materials, the invariable laws of nature, scientific formulas and other reasonably exact phenomena that follow a definite action and reaction course. Individuals in society, however, do not react with the same exactitude as do the materials and forces of nature. Engineers have difficulty, therefore, in comprehending just why individuals react differently and are inclined to employ force rather than apply persuasion in their dealings with other persons. The engineer who is ready to concede to other individuals the right to think and reason in the conduct of their own affairs will find himself in an excellent position to sell his ideas to employees, to employers or to prospective customers.

◆ **The marketing of products** consists first in creating a desire on the part of prospective customers for the product under question. In this selling field the engineer has a distinct advantage, for if properly informed on the product he is selling, he can prove by calculation how his equipment can be used in the customer's plant to save money spent for materials or make more money by increased production without proportionately increased expense. His knowledge of the engineering principles involved in his customer's production problems is an extremely helpful selling aid.

When a customer has been persuaded to purchase a product, the problem of delivery or distribution is confronted. This involves distances products are hauled, handling facilities at both the shipping point and the receiving station as well as transfers in transit, and every type of transportation—rail, water, trucks, airplanes, through such commerce systems as freight, express, parcel post and special messenger. This whole delivery problem is one for which engineers are trained from the design of the necessary equipment to the handling of the men who operate it. The objective is to carry out the delivery at the least possible cost.

In the strictly power field, engineers have a distinct opportunity to place in our national economy implements that will not only speed production, reduce costs, improve working and living conditions but help to conserve our natural resources of fuels, metals and forest products. Consider the possibilities along these lines of the gas turbine, the mercury-steam power cycle, the application of extremely high pressure steam, the broadening use of Diesel engines, further extension of interconnection between utility and industrial plant electrical systems, the packaged power plant, the power train, the barge plant, the wind driven power generator, the more extensive development of our hydroelectric resources, and one only begins to realize the enormous selling job that is confronting engineers.

They have conceived the possibilities of applying these ideas to the needs of the nation. If applied extensively, the projects must be financed and authority secured to proceed with construction before anything physical can be accomplished. If engineers cannot get public acceptance of their ideas nor obtain a market for their devices which have met laboratory requirements, progress in that direction is definitely delayed until men with both vision and sales ability undertake the task of commercializing the project.

The idea of developing marketing ability in engineers should be given serious consideration not only by educational institutions but by industrial establishments and engineers themselves.

◆ **Save Fuel or Else**—Every fuel user in the country is facing the grim realities of a fuel shortage before the present heating season is over. No matter what your plant may have done to insure an adequate supply, if the situation gets so acute that war production plants, or even apartment buildings, are without fuel, the government may demand part of your stored fuel to meet the requirements of others.

That may be bitter medicine to take, and a course of action for which you are in no way responsible, but situations must be met and the Solid Fuels Administration for War seems to be exerting every effort to see that hardships, if they cannot be completely averted, are at least distributed.

Indicative of the course being followed by the government are a number of the directives which have recently been issued, as for example:

"Directions to shippers of Indiana coal allow them to ship up to 100 per cent on the January order of an industrial consumer having less than 21 days' supply on hand. But orders for the entire month of January from industrial consumers having 21 days' or more on hand are reduced by 15 to 50 per cent, the largest cut being made in the orders of those with coal on hand sufficient for 90 days or more."

Request dated January 10 to producers in Districts 7 and 8: "Until Monday (January 15) consign no coal north of Pittsburgh, Youngstown, Akron, Indianapolis, Springfield, Ill., and St. Louis, Mo. By-product coal for steel or gas may be consigned to any point."

Directives of this sort are in marked contrast with the National Fuel Efficiency Program which calls for co-operation and offers suggestions for obtaining highest efficiency in the use of fuel with the benefits all going to the plant owner.

Those who have not enlisted in this program for saving fuel are overlooking an opportunity to secure information compiled by the highest authorities in the country on combustion and efficient use of fuel created energy. The entire country is organized to give service to fuel users through co-ordinators and regional engineers who are volunteering their services. This program deserves the whole-hearted support of all industries.

Three Modern Steam Generators R

New steam generating plant at Iroquois Works of Youngstown Sheet and Tube Co. at Chicago uses blast furnace gas as primary fuel . . . Oil is burned when gas shortages develop . . . Pilot lights for blast furnace gas burners use coke oven gas . . . Automatic combustion and feedwater control . . . Plant has been in operation 24 months and this article gives an account of the operating and maintenance problems over that period

By Paul R. Duffey

Special Engineer, Youngstown Sheet and Tube Company

FOR SEVERAL YEARS The Youngstown Sheet and Tube Co. had under consideration the replacement of 15 overage steam generating units, located at their South Chicago "Iroquois" Works. This plant primarily, produces pig iron and furnace coke. It is located adjacent to the shore lines of Lake Michigan and the Calumet River in the highly industrialized south side section of Chicago.

After a careful analysis of the old steam generating plant, building, and equipment, it was definitely established that the economical procedure to follow would be to leave the old plant intact, and erect a new complete plant adjacent to the old plant. On this basis the initial plans and specifications were drawn up for the new project, and then a general contract was executed with the Rust Engineering Co. of Pittsburgh, Pa., to undertake certain details involved in the project and erect the new plant on a ready-to-operate basis.

Orders for the principal building materials and plant equipment were placed late in 1941. Ground was broken in February 1942, and the first steam was generated in the new plant on December 7, 1942.

Because of wartime restrictions established after the project was undertaken, there was an appreciable slowdown in completion, and in some instances, changes were made at the last minute requiring substitutions in some important items of material, and certain refinements were omitted for the time being, to be undertaken at some future time.

In describing the various main facilities of this new plant, an attempt will be made to incorporate a brief outline of operation and maintenance problems after twenty-four months of operation.

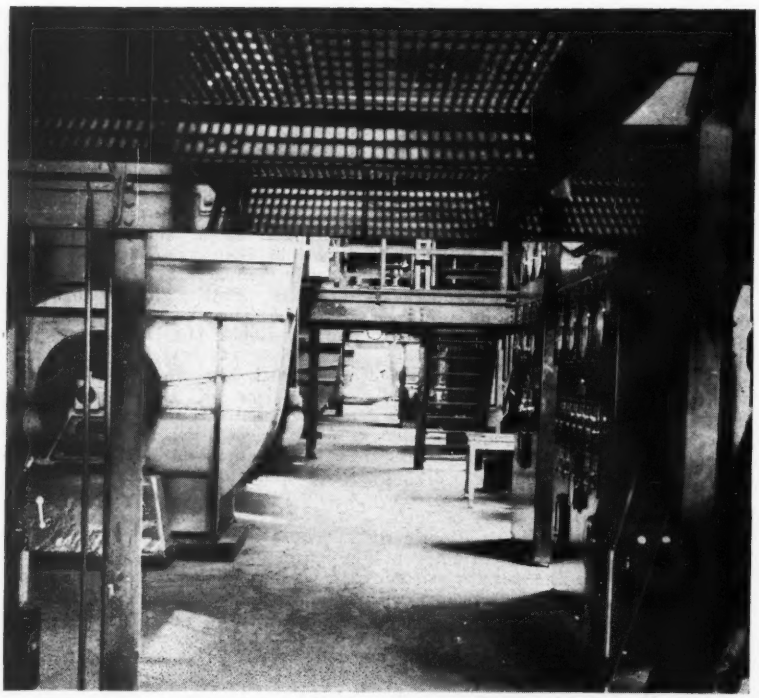


Fig. 1. Main firing aisle, showing forced draft fan and control panel for No. 2 Boiler, and the Bailey Master panel. Note the cleanliness and general accessability with the burner operating platforms overhead

1. PLANT BUILDING: This consists of all steel construction 176 ft 2 in. by 69 ft 2 in. by 40 ft 0 in.

The steel frame work is supported from concrete piers, set on good solid soil. The entire building including roof and louvre type ventilating monitor is covered with standard gage Robertson Protected Metal. Liberal natural lighting is obtained through the use of large sections of glass panels set in steel frames, in the sides and ends of the building. Certain sections of sash may be opened and closed. The roof monitor is provided on either side of its run with stationary and adjustable type of louvre ventilators.

The East End of the building, 69 ft 2 in. by 56 ft, 2 in. by two story height, is used to house on the ground floor the water treatment plant — pressure filters, chemical mixing tanks, chemical pumps, back wash pumps and sludge re-circulation pump. A bag elevator has also been provided for elevating chemicals to the second floor. The second floor provides space for storing approximately two carloads of lime and soda ash. There is also a liberal size wash and change room, and chemical control laboratory. The water softening tank (reaction tank), 40,000 gph capacity in treated water, is located in a space adjacent to the water treatment plant bay, and on the outside of the building.

Experience, after 24 mo operation indicates conclusively, that the water softening tank should have been located inside of the main building structure. The cold winters and high winds have necessitated making a number of refinements to equipment supplied with the tank and for protection of the operators.

The West End of the building will eventually be extended for a fourth steam generating unit. In view of this later addition, provision has been made for the removal of the Robertson metal sheets, sash and frames, etc., in such manner that practically all of the material may be used again with a minimum of waste.

In the North Side of the building, there has been provided three removable

Replace 15 Over-age Boilers

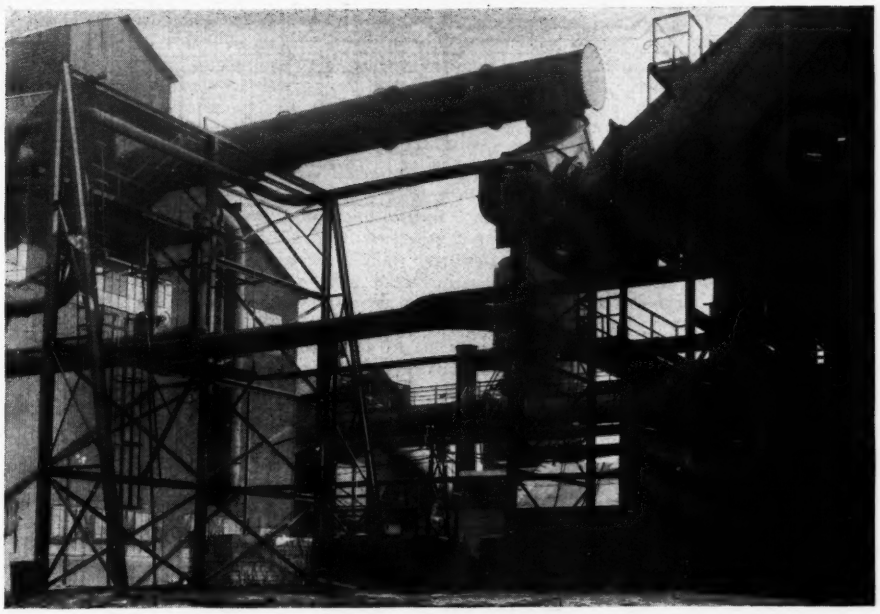


Fig. 2. View at the west end of the building showing the Prat Daniel Multitubular dust collectors and the Brosius blast furnace gas valves on the outlet from the cleaners to the gas distribution fitting. This also shows the 5 ft gas main serving the steam generating plant

panels 20 ft, 6 in. wide by 14 ft, 8 in. high, one in each bay nearest induced draft fans, which can be readily removed and replaced by use of locomotive type yard crane, without dismantling. The reason for providing removable panels, permits ease in removal of the induced draft fan rotors, shafts, or turbine drive, for repairs or replacement, provides ample space for extensive work on this equipment and it will certainly eliminate damage to the metal sheeting, steel bracing, etc., which would otherwise have to be removed and replaced one sheet at a time. Maintenance costs should be low.

In the east end of the building there has been provided a double width sliding door 12 ft wide by 10 ft high to facilitate ease in unloading of chemicals, anthrafilt, etc., for the water treatment plant and if necessary, the removal of a pressure filter unit.

Three single doors have been conveniently located for use of operators in and out of the building and one double width sliding door located in the south side of the building for use in removal of a forced draft fan unit, etc., as occasion may require. The roof structure was designed in such a manner and with sufficient strength to amply support the 5 ft blast furnace gas main; the 30 in. Brosius valves and motor drives serving the six individual blast furnace gas lines to gas burners and the stair runs and platform work to this elevated section of the building. The unit heaters employed for heating the building are suspended from the roof truss work. Roof trusses also provide support for suspended platforms front and rear of the steam generating units.

A monitor 14 ft wide by 6 ft high, fitted with side operating and side stationary louvre sections, has been provided across the top central section of sloping roof for a distance of 122 ft. The purpose is to ventilate the building and in the winter the operating louvre sections can be closed if desired. In any event, good ventilation is required on account of the types of gas fuels being used. A bad leak in a gas valve or line could do considerable personal, as well as property, damage, if the building is not properly vented. The main floors through the building are of concrete. Floors were dust and oil proofed at time of laying. All below floor level trenches are of liberal size, and they are constructed with sufficient slope to assure drainage to a central sump. Trenches are covered with steel subway type grating.

Base soil conditions for the entire project were found to be such that piling was unnecessary. Liberal design of footing and ample reinforcement sufficed. After 24 months' service, no defects have been observed.

STEAM GENERATING EQUIPMENT. Three 100,000 lb per hr, continuous rating Babcock and Wilcox Co., 250 psi, design pressure, 500 F, total steam temperature, type "F" integral furnace two drum type steam generators, 12,922 sq ft, heating surface each were selected for use. Each unit is equipped with 8600 sq ft, B & W tubular type single-pass air heater, cyclone separator type drum baffling and loop type superheaters. Diamond soot blowers, Yarnall-Waring water columns, Edward non-return valves, Okadee blow down valves and Allis-Chalmers steam purity recorders are also part of each unit.

B & W Co. Inter-tube type blast furnace gas burners, and coke gas burners were installed, also B & W steam-atomizing type of fuel oil burners.

The steam generating units were designed for a maximum peak output of 125,000 lb steam each for a peak period not exceeding one hour continuous at any one peak. The maximum allowable boiler water concentrations were established at 3500 ppm, and 3 ppm total soluble solids in the steam. Continuous blow down connections have been provided one at each end of the water-steam drum of each unit. One chemical feed line has been installed for direct after treatment to each water-steam drum.

During the first six months of operation the usual growing pains accompanying the starting of similar projects were experienced; in other words, finding the bugs and eliminating them. Bear in mind, please, that in starting this plant the entire operating force was composed of men selected from the employees in the old out-dated plant, and not a single man in the lot had any previous actual experience in the operation of modern steam generating equipment.

In starting up there was experienced, after a few weeks' operation, high exit gas temperatures leaving the units. This condition was improved once the correct air-fuel ratios were established from CO_2 data and practical application to correct firing. Our next important step was to maintain clean exterior surfaces of the generators, by removal of dust accumulation, by proper use of the soot blowers, and adequate hand lancing.

At this juncture some difficulties were experienced with our soot blowers. However, after installation of a series of

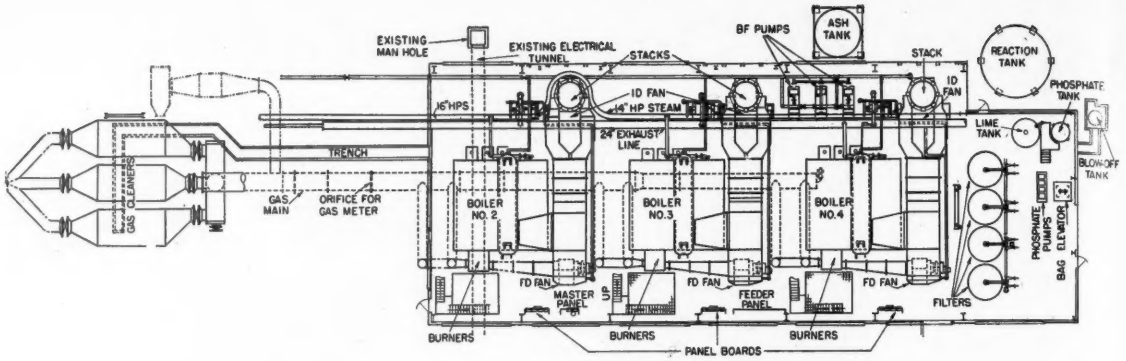


Fig. 3. Plan of the new boiler plant showing the arrangement of the blast furnace gas mains

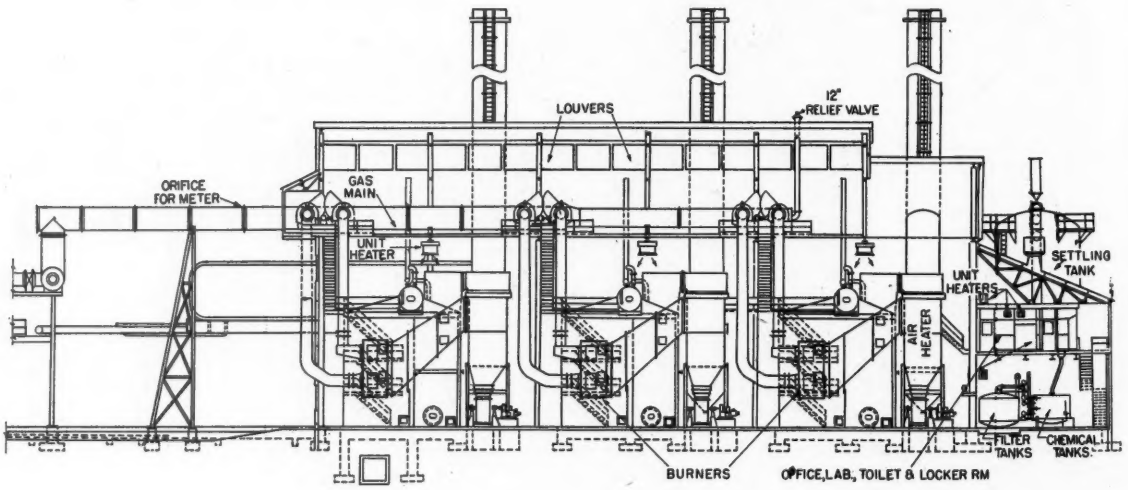


Fig. 4. Longitudinal elevation of the boiler house

lance doors and ports, and adhering to definite schedules of operation of the blowers, plus hand lancing; exit temperatures are held well within the range of the expected performance data. Soot blowers are operated once each 8 hr. Hand lancing is undertaken in a very thorough manner once in 24 hr. The furnace floors are lanced clean once in each 24 hr. Collection hoppers are evacuated once in each 24 hr. The steam generating units are each operated 120 to 150 days between outages for external cleaning of heating surfaces.

The primary fuel used is dust-laden saturated dry blast furnace gas 83/90 Btu 225 F, average temperature in the 5 ft inlet gas main serving the steam generator plant.

Three Prat-Daniel "Thermix Multitubular Dust Collector Units" were interposed in the 5 ft gas main in such a manner that each unit could be closed off for inspection and/or cleaning without affecting the two remaining units. Normally all three units are in service.

From available data it has been determined that the Thermix cleaners remove around 65 per cent of the dust particles in the gas. The dust is composed of principally 0.7 per cent coke, 3.5 per cent limestone, 4 per cent Eq Sodium Sulphate and 91.8 per cent iron ore as Fe and Fe_2O_3 by difference.

Elutriation tests of the dust in the gas before the cleaners and after cleaning indicates conclusively that the dust particles passing through the cleaners are in the 35 to 40 micron size, or in other words, 95 per cent of the dust passing through the cleaners readily passes through a 325 mesh screen. The particles after cleaning are apparently 100 per cent 40 micron size or smaller.

Tests have indicated that practically all of the coarse dust particles and a representative proportion of finer particles are removed before the gas enters the combustion furnace of steam generators.

Due to the potential dirt problem with dust-laden, saturated dry blast furnace gas, steam generator outlet gas temperatures may increase as much as 150 F over expected performance data. This is due to the fouled or dirty heating surfaces. Many plants using similar uncleaned gas fuel resort to scheduled cleaning outages after a 45 to 60 days' run. Excessive draft losses go hand in hand with higher outlet gas temperatures, giving a definite indication that regular and thorough cleaning of heating surfaces is required.

Experience has been that the Prat-Daniel "Thermix Multi-tubular Dust Collector Units" in removing all of the coarse dust particles give very satisfactory control over maintaining sufficiently clean heating surfaces by regular use of mechanical soot blowers and hand lancing, thus permitting operation from 5 to 10 months between scheduled cleaning periods.

The steam generating plant consumes around four and one-half million cubic feet of blast furnace gas per hour when generating 300,000 lb of steam, which is the normal and continuous rating of the plant.

Dust removal from the collection hoppers under the Prat-Daniel cleaners and from the various collection points of the steam generator settings is by means of a United Conveyor Corporation's Nu-

veyor system with silo storage and dustless unloader to railroad cars where the collected material is shipped to our ore sintering plant. The collected material approximates one seventy-ton capacity hopper car every 36 to 40 hr.

Secondary fuel is regular 10 to 14 gravity fuel oil, 152,000 Btu per gal and is used only at such times as there may be a shortage of blast furnace gas. Shortages sometimes occur when a furnace is on check or the volume of blast reduced for other purposes. Fuel oil is then required and is brought into service on hand control. The relations between oil fuel and combustion air are established by hand control from the operating panel. Such units as are placed on oil fuel are adjusted for base loading and the swing is taken on units fired with available gas.

The main reason for not having oil fuel firing on the full automatic control system was decided on the basis of a desire to use all available blast furnace gas and only sufficient oil fuel to satisfy operation. Also, there was the thought in mind of reducing the possibility of furnace disturbances when firing the two fuels.

Coke oven gas is used regularly for maintaining six pilot lights for the blast furnace gas burners and oil burners. About 7500 cu ft of this gas is used per hour for this purpose. Coke oven gas is a salable product and would be used for fuel only in case of extreme emergency or at such time as excess gas would not be sold. (This rarely occurs.)

Combustion Control and Feedwater Control System

The entire combustion control and feedwater control system was manufactured by Bailey Meter Co. In addition to the regular Bailey equipment there was added Parker blow down type manifold fittings for all multi-pointer gages and where required, there was also added Bailey settling chambers to a number of meter connections. Conventional type of vibration dampening devices were used to mount the steel control panels and care was used in making all piping and electrical connections to instruments mounted on panel boards to insure that connecting strains and vibrations would be held to a minimum.

The feedwater regulators are Bailey 3-element type and Bailey drum level control was also provided. The operating medium for all control apparatus is compressed air and in order to insure clean and moisture-free air, Bailey twin type coke filters were installed and a satisfactory home-made moisture trap was installed.

The system is arranged for automatic compensation of the air flow mechanism so that the steam flow-air flow relation will at all times be an indication of combustion efficiency regardless whether blast furnace gas or fuel oil, or both, are being fired.

The equipment supplied by Bailey performs in a very creditable manner and after 24 months' service, actual control troubles have been nil.

Fans and Turbine Drives. Forced and induced draft fans for this plant were manufactured by Buffalo Forge Co., and each is driven by a suitable Elliott Co. steam turbine. The forced draft fans are No. 8½ double width, double inlet type, 165,000 lb air per hr at 10.2 in. SP, 1200 rpm, 87 hp, at 105 F complete with inlet guards and screens. To date these fans have performed in a very satisfactory manner. Maintenance has been nil.

Forced draft fans are each driven by 87 hp Elliott, Type 2 BY, horizontal steam turbines with built in geared units. The turbine units are built to operate at 4800-1200 rpm. They will develop full rating with a steam pressure of 150 psi.

Turbines and fans are flexibly connected by means of Fast flexible couplings. Speed control is governed by use of a Bailey steam flow control valve of the diaphragm actuated type, responding to loading pressure established by steam pressure on control system. To date, turbine and coupling maintenance has been nil. Thorough inspection is made at each regular outage period and there is usually a complete oil change.

Realizing that combustion gases passing over the heating surfaces of a blast furnace gas fired steam generating unit runs approximately 70 per cent greater for a given steam output rate than for solid or liquid fuels; exit flues, ducts, and gas passages were designed to conform to these special conditions. A No. 15 double width, double inlet type induced draft fan 320,000 lb gas per hr at 9.7 in. SP, 870 rpm, 321 hp, at 575 F, complete with inlet boxes, full housings, renewable scroll liners, louvre type inlet and outlet dampers and boxes, self-aligning water cooled bearings, and pedestal bearing supports were selected.

No. 15.2 double type SC wheels were supplied. This wheel was given considerable thought along the line of erosive wear. Buffalo Forge Co. added wearing strips on either side of the center plate, and welded ridges were liberally added across the face of the blades. All openings between where blades fit against the center plates and outside flanges, welding was added to insure that erosive dust would not find a toe hold cutting action in such places.

The louvre type dampers on the inlet boxes are set in position by hand after deciding the desired static pres-

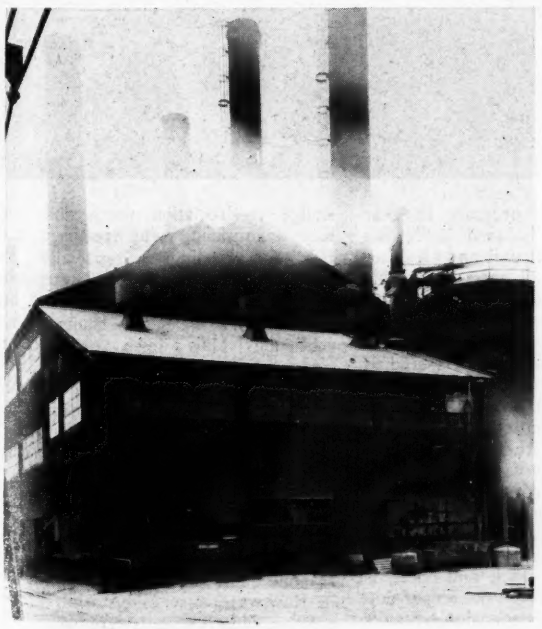


Fig. 5. View at the east end of the building showing the Permutit chemical reaction tank, the double doors for use in handling bulk chemicals, etc. This view shows the two story water treatment section of the building

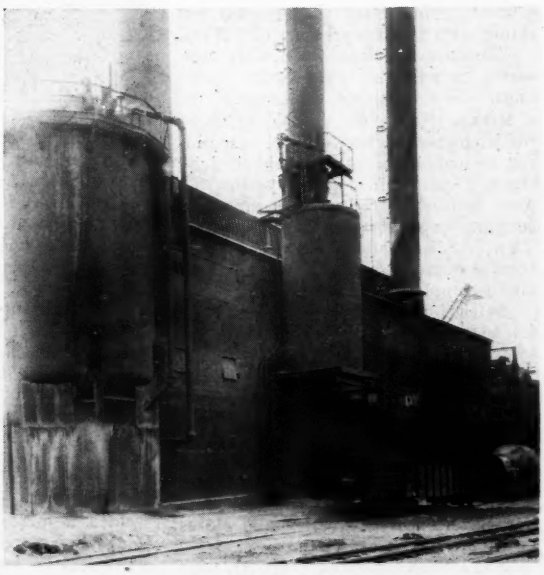


Fig. 6. The north side of the building showing the Permutit chemical reaction tank. This view also shows the United Conveyors Co. ash disposal silo and dustless unloader

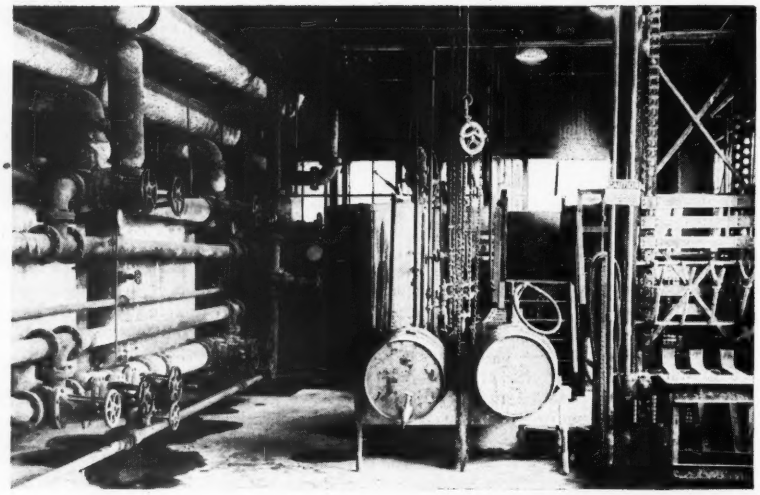


Fig. 7. (Above) Water conditioning plant showing pressure filter, chemical tanks and bag elevator

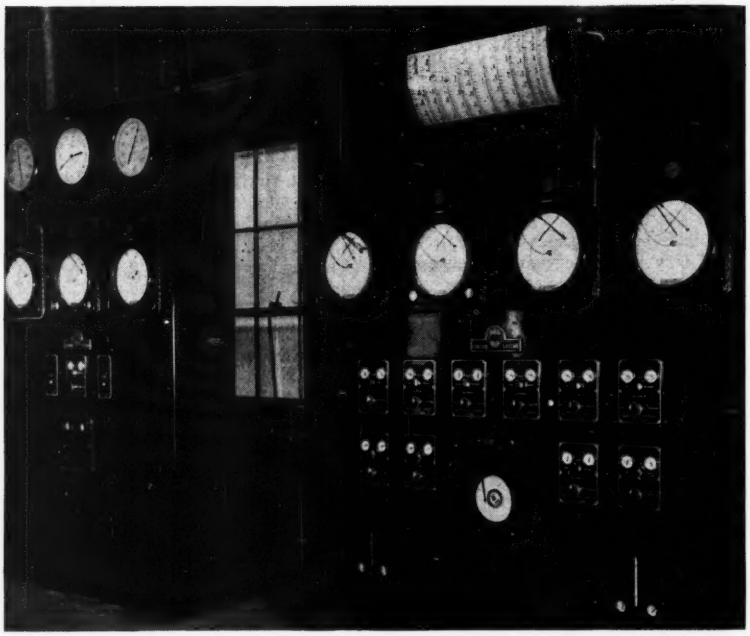


Fig. 8. (Right) The Bailey Master control panel at the left and No. 2 unit operating panel at the right

sure at this point and the outlet louvre dampers are operative from a Bailey control unit in conjunction with the Bailey furnace draft control, and Bailey speed control of induced draft fan steam turbine. Maintenance of induced draft fan wheels to date has consisted chiefly in maintaining the wheels in balance. Very little wear was observed on the fan wheels at the last regular inspection. Some erosion was noted on the scroll liners.

Induced draft fans are each driven by 310 hp Elliott, Type 2 Cy horizontal steam turbines, with separate 16 in. reduction gear units. These turbine and gear units are built to operate at 4700-870 rpm. They will develop full rating with a steam pressure of 150 psi.

Turbines and fans are flexibly connected by means of Fast flexible couplings. Speed control is governed by a Bailey steam flow control valve of the diaphragm-actuated type, responding to loading pressure established by steam pressure on control system. To date turbine, turbine gear unit and coupling maintenance has been nil. Thorough inspection is made at each regular outage period and there is usually a complete oil change.

Safety interlocking between the forced draft fan and induced draft fan system is substantially:

1. Failure of an individual forced draft fan closes off the individual burner line butterfly valves on gas and/or oil supply to the steam generating unit.

2. Failure of blast furnace gas supply when on gas, closes the individual burner line butterfly valves and closes down the forced draft fan.

3. Failure of induced draft fan trips out all other equipment and leaves induced draft fan dampers in wide open position.

4. Failure of oil pressure in gear reduction unit of induced draft fan trips out forced draft unit and all other equipment. A low oil pressure audible alarm is also provided.

STACKS. Each steam generator has an individual gunite-lined self supporting steel stack. Each stack is erected on a steel supporting structure designed in such a manner that the induced draft fan outlet damper box provides entry into the bottom of the stack by way of a 9-in. expansion connection set on top of, and fastened to the damper box. On top of expansion joint there is a short steel connection which is neatly formed to fit inside the bottom of the stack and there is welded in place. The 9-in. expansion joint takes care of expansion. Stacks are 7 ft 5 in. inside diam and top elevation above floor line is 125 ft, overall. Actual stack is 105 ft, overall length. Gunite lining is 2-in. thickness. After 24 months' service stacks are in good condition.

Water Treatment Plant and Feedwater Lines to Steam Generators

A Permutit Co. hot lime-soda water softener system was selected for this steam generating station, and was designed to furnish 40,000 gal of treated water per hour, continuous rating. Pressure filters, containing graded layers of "Anthrafilt" filtering media were supplied. Each filter was equipped with a Permutit mechanical rotary surface washing device. The filters were designed to supply a normal flow of 46,000 gal of softened hot water effluent for boiler feeding.

Chemical mixing tanks with mechanical agitators, and mechanical feed control were supplied together with the required chemical feed pumps, sludge re-circulation pump and filters back wash pump. After treatment facilities for feeding a specially prepared chemical direct to the water-steam drum of each boiler unit has been provided. A Permutit standard type continuous blow down and heat recovery system was included, together with Parker individual unit sampling coils and sample draw off connections.

The source of raw water to be treated is obtained from our Calumet River intake. The water intake is about 3000 ft from point where the river and Lake Michigan meet. The river is a navigable stream and considerably used during the open lake season.

Raw water enters the station through a 10 in. pipe line and water is strained by passing it through a Twin Elliott basket type strainer before passing on to the Permutit type "AD" Lime-Soda Softener.

From the softener the chemically treated, deaerated hot water flows by gravity to the respective filters. After filtration the water is pumped to the respective steam generating units as required. Bailey Meter Co. 3-element feedwater regulators in conjunction with Bailey drum level control maintain a closely regulated and highly dependable feedwater operation.

Boiler feed pumps are constant speed Worthington Multi-stage centrifugal type, direct driven by steam turbines. The feed pumps represent mainly the only equipment removed from the old boiler house and re-installed in the new house.

Deady Chemical Co. "After Treatment" is fed direct to the water-steam drum of each steam generating unit by means of individual Milton Roy motor-driven, automatically controlled, chemical feed pumps. The pump piping is so arranged that any pump selected, including a spare pump can pump into any generating unit. This interchangeability has been found to be very advantageous. When the pumps are not passing "After Treatment" the arrangement permits the pumping of condensate water through the piping system, thus insuring clean piping and valves and no settling out of chemicals in the system. The system has worked out very well.

The continuous blow down system is practically a duplicate of that used in other Youngstown Sheet and Tube Co. plants where similar type steam generators are installed. A continuous blow down take off from each end of the water-steam drum has been provided. Blow down is controlled by specially constructed "Flo-control Valves," the piping from flow-control valves enters the built in flash compartment of the softening tank where 17 per cent of the blow down is flashed into steam. In the piping between flow-control valves and flash compartment the blow down samples are drawn off through the individual Parker coils and sample draw off connections. Blow down water level in the flash compartment is float controlled, and after flashing into steam the controlled draw off water passes through a heat exchanger and thence to sewer. None of the blow down drainage is used over.

Operating Problems

Operating problems during the first several months were many and of various range of seriousness in affecting operations. Some of the troubles were due to equipment, some to operation, and some to conditions beyond immediate control. After 24 months of operations, the plant is functioning very well, and at present time several women operators are employed.

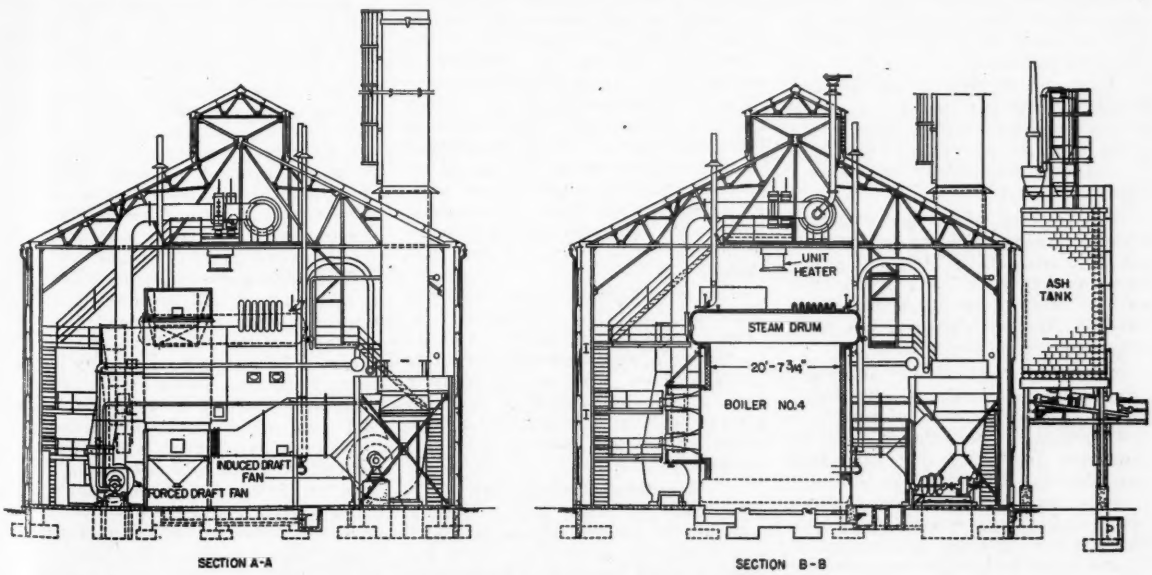
The main mechanical difficulties were:

1. The pilot operated liquid level controller supplied with the equipment to maintain raw water level in the softening tank was too small. This was due to a mix up in supplying the valve manufacturer with correct water pressure data. The operation struggled along for several months in a more or less hit and miss fashion until a valve built to meet the requirements could be secured. The delay in securing the new valve was partially due to governmental restrictions.

2. Some time after placing full load on the plant there was noted a more or less gradual loss in water temperature in the heated water in the softener and in effluent water from deaerator. Inspection indicated a crystalline stalactite formation in cone shape deposits over the distributor openings in the perforated plate installed between the steam chest and the scrubber section of the built-in deaerating heater. These stalactites formed on the steam side of the plate. The steam supplied to the deaerator was chiefly exhaust steam from fan and boiler feed pump turbines, however, as the turbines did not supply a sufficient amount of exhaust steam for heating the water, it was found necessary to augment steam requirements by adding through automatic control a substantial amount of reduced pressure live steam superheated to 500 F total temperature. As the stalactite cone shaped deposits on the steam distributor plate were apparently the first such experience reported to the Permutit Co., who had many similar plants in operation, they, after a thorough investigation of the problem, concluded that the cause of these deposits was due to the drying effect of the superheated steam. Accordingly, the supplementary superheated live steam was added directly to the steam space of the softener at the top rather than into the steam chest of the deaerator, as is the usual procedure. Also it was found advisable to change the shape and size of openings in the exhaust steam distributor plate.

Oxygen determinations of the effluent indicated that with the new arrangement of openings in the steam distributor plate, the deaerator continued to give zero oxygen. The equipment has now been operating for more than a year since the change was made and there is no indication of any deposits forming and the exhaust steam pressure loss through the distributor plate continues low and unchanged and the deaerator continues to deliver water of zero oxygen. Internal inspection made in June, 1944, conclusively indicated that this troublesome condition was corrected.

3. During rainy seasons and under certain wind disturbances the normal directional flow of the Calumet River may be reversed so that it drains into the lake. Water entering the intake under such circumstances has practically the same effect as that of a storm sewer near an industrial district.



Figs. 9 and 10. Cross sections through the plant

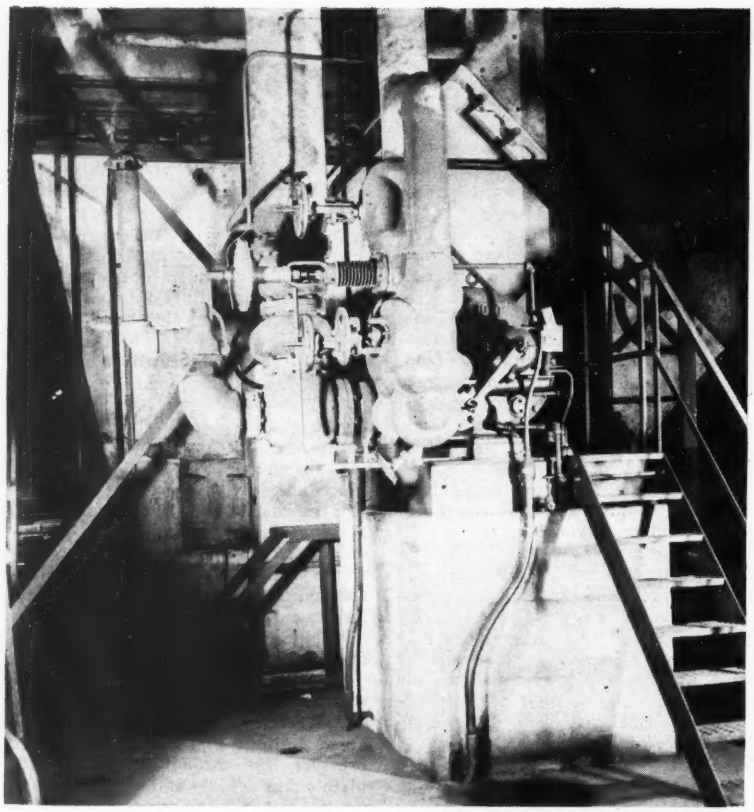


Fig. 11. Induced draft fan drive and fan. Note the operating platforms and stair runs. Inlet dampers are hand operated (right). Outlet dampers (top left of fan) are on Bailey control

At other times the raw water contains a relatively large amount of terracotta colored suspended matter, similar in structure to the usual flue dust found around a blast furnace works. This contamination is frequently so finely divided that it acts to retard proper clarification of the settled water in softener rather than to aid it. Contamination of the raw water intake with effluent waste from a nearby thickener unit also creates a further retarding factor.

As a result of some of these unusual conditions with this raw water supply, it was found that the turbidity of the softened water was unduly high and to reduce this turbidity, two direct steps were taken:

(a) The use of a floc coagulant, manufactured by The Deady Chemical Co. of Kansas City, Mo., and designated as Deady "C" and successfully used at other plants for a long time, has also been established at this plant with very satisfactory results.

(b) Sludge re-circulation of around 35 gpm has been instituted with sludge taken off from the conventional blowdown section of the softening tank and discharged into the top of the tank near the water level of the chemical reaction chamber. As a result of these two definite steps, a satisfactory turbidity is now obtained in the range of 15 and under with proper control.

4. As a result of the raw water being so difficult to clarify, the pressure filters were carefully inspected at periodic intervals, for the purpose of checking the "Anthrafilt" filtering media for accumulation of mud that had not been eliminated by proper back wash.

In June, 1943, the filter media in all filters was so badly contaminated that it was replaced. Up to that time the value of regular and consistent use of the rotary surface washing device, located directly above the top of the "Anthrafilt" bed was not realized. A special type of indicating device was installed for the operator to observe actual operation and effectiveness of the rotary washer. As a consequence of these improvements, an internal inspection of all filter units in June, 1944, indicated that the filters were normal and the quality of the effluent softened water was satisfactory and zero turbidity.

It was realized, of course, that with any plant operating continuously at capacity rating, many factors can arise to change a good operating condition into a poor one, hence perhaps we have been a trifle too critical at times to assure ourselves that we can operate at all times with a minimum of interruption.

Reports and Operating Data

A daily log sheet is in effect for compilation by the steam generator operators, and a separate daily log sheet is made out by the water treatment operators.

The water treatment plant log sheet covers the various desired factors and chemical results determinations of raw water, softening tank influent and effluent, filters-operation and backwash. Boiler water concentrations from continuous blowdown, meter readings, chemical quantities and general operating remarks.

Raw water quantity is recorded and integrated. Reaction tank temperature is recorded. Deaerated water temperature is recorded. This temperature substantially represents boiler feed temperature. The level of water in the deaerated water storage is indicated at two locations, one on the operating floor for benefit of steam generator operators, and second indicator is located on a panel with the recorder in the control laboratory. A high and low water audible alarm and lights are also provided. It is highly important in this plant to maintain continuous and uninterrupted operation. Live steam make up in pounds per hour to the reaction tank is also recorded.

In conclusion a careful review of this entire project indicates that there was accomplished a reasonably creditable job, particularly so when one considers the fact that the project was undertaken about the time WPB, and other restrictive government agencies were going through their worst growing pains with result that neither the principal suppliers of equipment, general contractor, or The Youngstown Sheet & Tube Company knew at times the right course to pursue.

After 24 months' operation, suffice to say much has been learned, however, in principle there would be little to change if designs should be requested for a similar plant.

As noted throughout this article, reference has been made to having replaced 15 over-age units. Operation is normally with the three new units. When necessary to have one new unit off for cleaning, etc., there is placed in service 3 Erie City units which are held as reserve until such time as Management decides on a fourth modern unit for which building extension space has been provided.

The 15 over-age units plus the three Erie City units would not have been able to carry the continuous burden of supplying steam of operation of three blast furnaces and a coke plant at rated capacity. Maintenance and operating problems would certainly have become a very serious factor to reckon with.

By utilizing available blast furnace gas, the use of coal has been entirely dispensed with, and the new plant is not set up for coal burning. Coke breeze is burned under Erie City units at such times as a new unit is off for cleaning. Fuel oil is fired sparingly and only when absolutely necessary. Coke oven gas is used principally for pilot lighting. Reduction in actual fuel expense has certainly justified the new modern plant and there has also been a most substantial reduction in operating labor at a time when labor is a serious problem. Costs are well in line with estimated data.

Centrifugal Pump Control

Part III

Analysis of control elements . . . Two distinct classes of controls, corrective and protective . . . Four functional elements in all pump controls: measuring, impulse, relay, power . . . How four elements are related in practice . . . Influence of operating medium . . . Choice between automatic and manual control and many variations in between . . . Details of analyzing control method

By Igor J. Karassik ***Application Engineer, Worthington Pump & Machinery Corp.***

Correction Note: — If there seem to be omissions in the text of Part II in your copy of the January issue, read the pages in this order: 84, 86, 85 and 87. They will then read correctly. Pages 85 and 86 got interchanged while a correction was being made just before going on the press.

DESCRIPTION OF THE FUNDAMENTAL FUNCTIONS of centrifugal pump controls presented in the preceding article* leads to a logical subdivision of controls into two distinct classifications: corrective and protective controls. Corrective controls are obviously directed at changing some relationship within the pump system to compensate for changes in the conditions imposed upon the system. This is the case, for instance, when the delivery of a boiler feed pump must be reduced because the boiler demand has decreased, while the boiler level must be maintained constant. Protective controls, on the other hand, are directed at protecting the pump or the system against certain harmful combinations of conditions or, in the event such conditions have arisen, at eliminating them in the shortest possible time. Thus, the control of a by-pass in a boiler feed pump discharge, intended to prevent operation of the pump at flows so reduced that overheating will occur, is a protective control.

These classifications are important to visualize, because a great many features of pump control will depend on whether corrective or protective controls are involved. Of course, once in a while, the same control may be applied for either corrective or protective purposes. For instance, if it is intended to stop a centrifugal pump when sufficient water has been delivered to a reservoir, the float switch that stops the pump is a corrective control, as no specific harm will be done if the pump were to continue running somewhat longer. If, on the other hand, the same float switch is intended to prevent pump operation beyond the point where the water in the suction vessel has been completely drained out, so that the pump may not run dry, the control is a protective one.

Pump controls can be logically separated into four individual functional parts:

1. Measuring element
2. Impulse element
3. Relay of the impulse
4. Power element

Function of Measuring Element

Fundamentally, all control problems to be encountered in the operation of centrifugal pumps can be reduced to the problem of balancing flows, pressures, temperatures or combinations of two or more of these. As a result, the measuring element must determine some force or forces set up in the pumping system which change in magnitude as the quantity to be controlled varies. If the quantity in question happens to be fluid flow, this force can be created by a pressure differential across an orifice; if liquid levels are to be controlled, the difference in static head between the level to be controlled and some fixed arbitrary reference level provides this force; if a certain pressure or pressure difference is to be controlled, this pressure in itself provides the force to be measured. The main concern is to select the measuring element and its location in the pumping cycle so that it gives the simplest and most reliable indication of the quantities to be balanced.

Impulse Element

The impulse element is that portion of the control which does most of the thinking, deciding when the measured variable has reached a predetermined value or when it is properly balanced against some other variable with which it must remain in a certain correlation. If the control function is such that variation in the quantities to be balanced is to be constantly accompanied by the desired change in relationship, such as valve setting, pump speed or similar changes, the impulse and measuring elements are integrated. For example, if it is desired to reduce the pump capacity by throttling in some proportion to the reduction in the level in the supply reservoir at the pump suction, the force set up in the measuring element by the magnitude of the level acts directly as the impulse, which will ultimately be transmitted to the throttling valve control.

If, on the other hand, control of

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*Part I, discussing centrifugal pump characteristics, to show what must be controlled, December, 1944, page 74; Part II, on fundamental functions or objectives of pump controls, January, 1945, page 84.

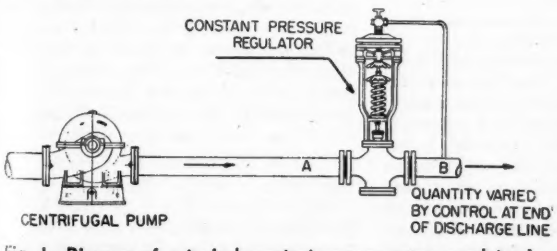


Fig. 1. Diagram of a typical constant-pressure pump regulator installed in pump discharge, to show relations between measuring, impulse, relay and power elements of control

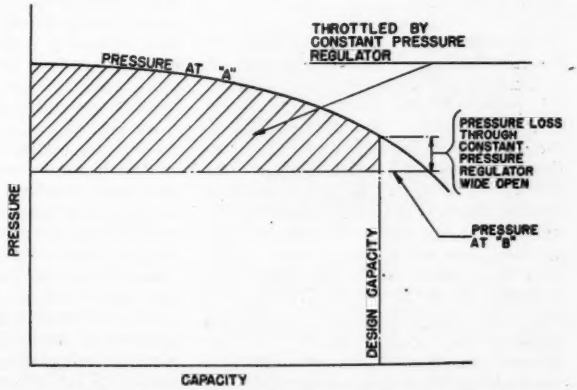


Fig. 2. Curves showing performance of pump in Fig. 1

Table showing various combinations of manual and automatic operations possible in controlling the throttling of a centrifugal pump discharge in response to changes in reservoir level at pump discharge

STEP OF CYCLE	OPERATION						
	FULLY MANUAL	SEMI-AUTOMATIC (a)	SEMI-AUTOMATIC (b)	SEMI-AUTOMATIC (c)	SEMI-AUTOMATIC (d)	SEMI-AUTOMATIC (e)	FULLY AUTOMATIC
MEASURING ELEMENT	MANUAL OPERATOR MEASURES LEVEL IN RESERVOIR WITH ROD	MANUAL OPERATOR MEASURES LEVEL IN RESERVOIR WITH ROD	AUTOMATIC DIRECT READING GAUGE GLASS INDICATES LEVEL IN RESERVOIR	AUTOMATIC FLOAT IN RESERVOIR REGISTERS LEVEL	AUTOMATIC FLOAT IN RESERVOIR REGISTERS LEVEL	AUTOMATIC DIRECT READING GAUGE GLASS INDICATES LEVEL IN RESERVOIR	AUTOMATIC FLOAT IN RESERVOIR REGISTERS LEVEL
IMPULSE	MANUAL OPERATOR REALIZES THAT LEVEL HAS INCREASED	MANUAL OPERATOR REALIZES THAT LEVEL HAS INCREASED	MANUAL OPERATOR SEES THAT LEVEL HAS INCREASED	AUTOMATIC FLOAT SWITCH RINGS BELL	AUTOMATIC FLOAT SWITCH RINGS BELL	MANUAL OPERATOR SEES THAT LEVEL HAS INCREASED	AUTOMATIC FLOAT SWITCH MAKES CONTACT ON RISE IN RESERVOIR
RELAY	MANUAL OPERATOR WALKS OVER TO VALVE	MANUAL OPERATOR WALKS OVER TO PUSH-BUTTON STATION	MANUAL OPERATOR WALKS OVER TO VALVE	MANUAL OPERATOR HEARS BELL AND WALKS OVER TO VALVE	MANUAL OPERATOR HEARS BELL AND WALKS OVER TO PUSH-BUTTON STATION	MANUAL OPERATOR WALKS OVER TO PUSH-BUTTON STATION	AUTOMATIC IMPULSE FROM FLOAT SWITCH TRANSMITTED ELECTRICALLY
POWER ELEMENT, OR POSITIONING	MANUAL OPERATOR CLOSES VALVE PARTIALLY AND THROTTLES PUMP DELIVERY	AUTOMATIC MOTOR OPERATED VALVE THROTTLES PUMP DELIVERY	MANUAL OPERATOR CLOSES VALVE PARTIALLY AND THROTTLES PUMP DELIVERY	MANUAL OPERATOR CLOSES VALVE PARTIALLY AND THROTTLES PUMP DELIVERY	AUTOMATIC MOTOR OPERATED VALVE THROTTLES PUMP DELIVERY	AUTOMATIC MOTOR OPERATED VALVE THROTTLES PUMP DELIVERY	AUTOMATIC MOTOR OPERATED VALVE THROTTLES PUMP DELIVERY

operation and, therefore, change in relationship is to occur only when the measured quantity reaches some predetermined magnitude, the impulse function becomes divorced from the measuring element and becomes operative only when the forces involved are balanced at the desired value. As an illustration, it may be assumed that the valve in the pump discharge is to be closed off whenever the suction level drops to some set value. The measuring element records at all times the suction level and balances a force proportional to this level against a selected force representing the desired minimum. As long as the measured force exceeds the predetermined force, the impulse is inoperative, but on reaching a balance between the two forces, the impulse mechanism sets in motion certain controls which will close the valve as desired.

Amplification of Forces

Sometimes, the force which is set up through quantity variation is of very negligible magnitude and cannot be used directly to actuate any control mechanism. An amplifying feature must then be incorporated into the control mechanism. This amplifying feature, however, might be more logically considered as part of the relay than of the impulse element.

Relay Element

As will be seen later, the relay of the impulse may or may not exist as a mechanism, depending on whether this portion of the pump control is or is not automatic. In other words, if the impulse element's function is to ring an alarm bell when certain conditions are detected by the measuring element so as to warn the operator, the function of the relay element will be accomplished when the operator walks over to a valve which the alarm has indicated must be throttled. On the other hand, in the majority of control mechanisms, the function of the relay element is to transmit the decision reached by the impulse element to the power mechanism which actually operates the control. This function can be discharged in a wide variety of manners and can be performed mechanically, hydraulically, pneumatically or electrically.

Power Element

The power element, the last of the four functional parts of a complete pump control, is that element which performs a change in some relationship in the combination of pump and pumping system, such as a change in the valve setting, a reduction or increase in the pump speed, or the stopping or starting of the pump. Again, the source of the power used in this element may be either mechanical, hydraulic, pneumatic or electrical. The choice of the power element operating medium between spring tension or compression, air, water, oil, steam or electricity is one which is of great importance in determining whether a control will or will not be fully successful in a given application. Unfortunately, the study of suitable operating mediums is a very complex one and can be treated only superficially in the limited space which can be devoted to it in a series of articles on centrifugal pump controls. The discussion of the operating power medium will, therefore, take place in the parts of this series of articles dealing with specific control applications. It must suffice for the present to state that different applications may frequently be best served by the use of one particular operating medium rather than of any other one.

How Four Control Elements Are Interrelated in Practice

We have assumed so far, in the interest of simplicity, that the four elements of a centrifugal pump control can be readily separated and examined in this dissected state. Actually, it frequently happens that the four elements and their functions are somewhat interlaced, introducing into our analysis an element of uncertainty with which we would much prefer to dispense. As an example, let us consider a constant pressure pump regulator installed in the discharge line of a centrifugal pump, as shown in Fig. 1. The pump is operated at constant speed, therefore the discharge pressure will vary with the quantity delivered by the pump. Let us further assume that the pump capacity is varied by some other control which need not enter into our present analysis. In the valve itself, the valve disc is mounted on the valve stem, the position of which is controlled by a diaphragm. The control chamber above the diaphragm is connected to the pump discharge line at the point B, where it is desired to maintain a constant pressure. The balancing force, corresponding to the desired discharge pressure, is provided by a spring. Any increase in the pump discharge pressure at B will act against the force exerted by the spring and cause gradual valve throttling. The valve will become partially closed, increasing the frictional losses through it and, therefore, increasing the difference between the pressures at A and at B, until the pressure at B corresponds to the desired value and balance has been reestablished. The pump performance is illustrated in Fig. 2.

In this particular case, the measuring element is the diaphragm, which reacts to variations in the pressure to be controlled. The impulse is provided by the spring which is calibrated to correspond to the desired pressure at B. The relay, in this application, does not exist; while the power element is, in the last analysis, a variable one. When the pressure at point B exceeds the desired value, the force required to partially close the valve and thus create additional artificial friction is provided by the controlled element itself. When, on the other hand, the pump delivery is increasing and the pressure at point A decreases, carrying with it a decrease of pressure at point B, the spring intervenes to provide the power required to reopen the valve. Of course, it could be argued that the power element consists of the difference between the hy-

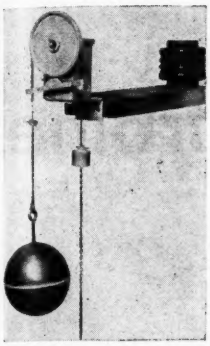


Fig. 3. Typical float switch used in control circuits of a-c and d-c automatic starters

draulic and spring forces respectively. The actuating force is positive for valve closure when the hydraulic force exceeds the spring force and negative, for valve opening in the reverse case. Regardless of the interpretation one may give to this phase of the control analysis, it becomes apparent that measuring, impulse and power elements are very definitely interrelated in this particular application.

Influence of Operating Medium

The same example may serve to illustrate certain differences which arise from the selection of the operating medium—either for the power or for the impulse element. In the control shown on Fig. 1, it was assumed that the desired discharge pressure at point B was represented by a valve spring, although the same function could have been fulfilled either by a weight or by some preset hydraulic or pneumatic pressure, to be introduced on the side of the diaphragm opposite the chamber where the pressure to be controlled is applied. While both spring loading and weight or pressure loading have their advantages, it is necessary to visualize the basic differences between the two types in order to determine the proper type for any given application. Insofar as spring loading is concerned, the important fact to remember is that the spring power is not constant but varies with compression. Thus, as the pump delivery decreases, the spring is compressed and in this compressed condition exerts more pressure in counteraction to the controlled pressure. Thus, the discharge pressure at B balanced by the spring action increases with a decrease in pump capacity, although this is not shown on Fig. 2 to avoid confusion.

Of course, if the maximum movement of the spring is very slight, the valve loading will be practically constant. If, on the other hand, the spring is to be operated in a wide range of compression, spring loading is not particularly well suited to provide constant loading, and weight or pressure loading is to be highly preferred.

Automatic Versus Manual Controls

While a great number of centrifugal pump controls are automatic in their operation and while most attention is generally directed to such controls, one should not forget that in many instances a choice must be made between manual and automatic controls. This choice is not a very easy one to make. It is considerably complicated by factors more of a psychological than of a technical nature and it must be admitted that proponents of both types of operation offer some very convincing arguments in support of their preferences. On one hand, engineers who favor manual operation wherever possible, state that automatic controls lead to neglect and indifference on the part of the operators. Thus, if a failure of control should occur at any time, the operator may be unable to remedy any harmful effects which might result, either through lack of knowledge or simply because he might be so dependent upon the proper operation of the control that he would not be available at the place where his attention becomes necessary. On the other hand, supporters of the automatic operation of controls claim that human response is never as rapid as that of mechanical elements and requires an excessively attentive attitude, all of which may lead to an equal or even greater incidence of failures than in the case of automatic operation. The decreased operating personnel requirements, furthermore, more than overbalance the greater initial investment in the automatic control.

Many Conditions Between Extremes

The author does not wish to enter into this age-old controversy, mainly because he believes that no overall rule or preference can be established in the choice between manual and automatic operation. In the first place, it is highly important to realize that the differentiation between the two types is not as sharp as some engineers may be led to believe. Between the two extremes of fully manual and fully automatic control, there exists a large number of intermediate arrangements, all of them semi-automatic in some one phase of the control mechanism. In other words, if one is to refer to the subdivision outlined earlier, separating control mechanism into measuring, impulse, relay and power or positioning elements, it is obvious that each of these separate components can be made manually or automatically operated.

To illustrate this, a typical control operation, involving the throttling of a centrifugal pump discharge in response to level changes in the reservoir at the pump discharge is described in the accompanying table. It will be seen that in addition to the fully manual and fully automatic controls there are shown five other methods of control in which some of the elements are operated manually and others automatically. Of course, there being four separate component control steps and two different methods of operation, that is manual or automatic, for each step, there will be altogether sixteen different possible arrangements. Of these one will be fully manual, a second fully automatic and fourteen will be impractical. For instance, it would be rather illogical to arrange automatic operation of all steps but the measuring element. However, the arrangements described in the table indicate that a rather complex chain of reasoning is necessary to determine the most suitable one and that to base the ultimate decision on a broad preference for manual or automatic controls is decidedly shortsighted.

Factors in Analyzing Control Method

Without attempting to prepare an exhaustive list of all the factors which must be considered, we may examine some of the most important of these factors and thus indicate the general character of the analysis which must precede a choice between manual and automatic controls. These factors are presented below, but not necessarily in the order of their relative importance.

Frequency of Operation—Is the control operation required infrequently or at frequent intervals, possibly constantly? The starting up of a standby pump on failure of the main pump, an operation which is apt to occur very rarely, is less in need of automatic controls than, for instance, the maintenance of a constant pressure in the discharge header, when variations in the flow delivery require constant repositioning of the regulating valve.

Expectancy of Operation—Is the control operation to occur at regularly scheduled intervals or is the requirement sudden and unexpected? For instance, the starting up of additional boiler feed pumps in a power plant, prior to an expected increase in load at certain times of the day, can be carried out manually quite readily. On the other hand, the start-and-stop operation of a transfer pump which delivers into a storage tank depends wholly on the varying rate of usage from the tank and, therefore, cannot be accurately predictable as to time.

Urgency of Operation—Must the controlled operation take place instantly upon the occurrence of certain conditions or can it take place at leisure? Basically, the differentiation here is one between corrective and protective controls. In the case of the latter, it is almost imperative that the measuring and impulse elements be automatic, lest the measuring element become the visual estimate of the degree of destruction of the equipment and the

(*Continued on page 75*)

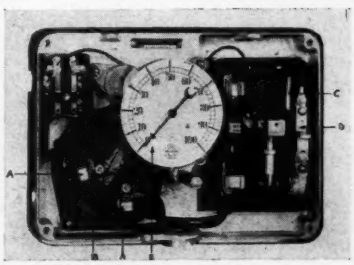


Fig. 4. Typical pressure governor, used as pilot device for pump motor starters. A—adjustable contacts. B—movable contact. C—relay coil. D—relay contacts. E—pressure gage. This particular unit is rated: Max. 600 v, 25 amp. Min. cut-in pressure 20 lb; max. cut-out pressure 80 lb; min. pressure range 2 lb

Details of 65,000-kw Harbor Steam Plant Turbine

By

C. C. Franck

Westinghouse Electric & Manufacturing Co., South Philadelphia, Pa.

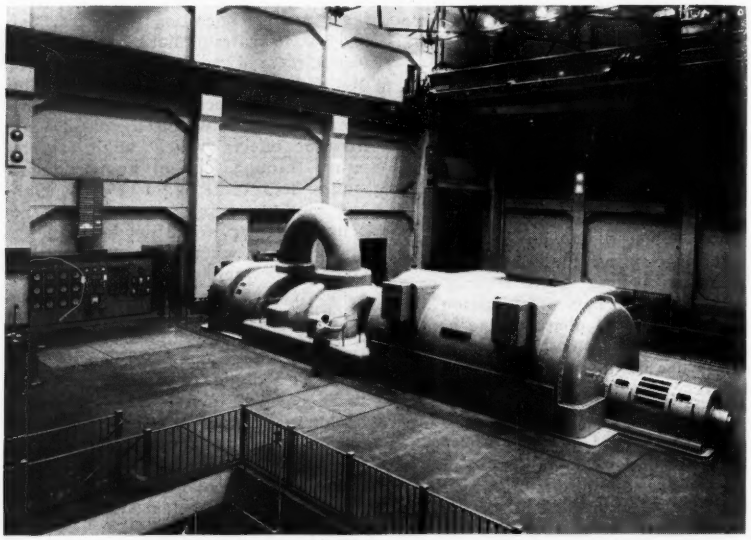


Fig. 1. Harbor Steam Plant turbine and generator

WHEN THE NEW TURBINE GENERATOR in the Harbor Steam Plant[1] at Los Angeles went on the line, it represented the largest single shaft, 3600-rpm tandem condensing unit ever built. The turbine is rated at 65,000-kw with steam supplied at 850 psi gage 900 F total temperature, and is designed for a maximum output of 75,000-kw.

The purpose of the unit is to operate in parallel with hydro capacity. During years of low water flow, the unit will function as a base load plant; and during years of plentiful water, the unit may be called upon to provide "spinning reserve." This called for a general-purpose unit operating at an estimated average capacity factor of the order of 50 per cent during its active life, with the added special characteristics[2] suitable for operating as "spinning reserve." The normal "spinning" load of 5000-kw was dictated by boiler characteristics which give stable operation at a minimum steam flow of 60,000 to 65,000 lb per hr. The "spinning reserve" type of service dictated that while the turbine would normally be generating only 5000-kw, an interruption in power supply from outside sources would impose full load immediately. Under this condition, full throttle steam temperature and normal steam pressure would not be reached until the boiler recovers from the sudden increase in steam demand, and an important design consideration was to correlate the boiler and turbine behavior.

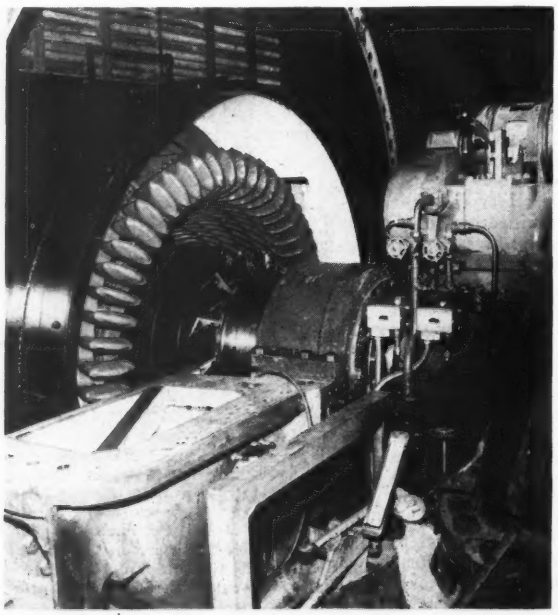


Fig. 2. Generator with end bell on turbine removed

Basis for Size of Unit

Nominal steam conditions of 850 psi gage 900 F were chosen on the basis of an estimated average capacity factor of the order of 50 per cent during the active life of the unit. As the six units operated by the City of Los Angeles at Boulder Dam are rated at 82,500-kva each, a new unit of approximately the same capacity was desired. The "spinning reserve" influenced the type and speed of the unit. The 3600-rpm class of unit was selected rather than 1800-rpm, since the rapid pick-up of load pointed to the desirability of smaller physical size of turbine with its resultant shorter time to reach equilibrium after a change in temperature distribution. The 3600-rpm class of turbine offered a further advantage in that for 65,000-kw rating it is of the tandem type, consisting of two relatively short elements sharing the over-all temperature gradient. The largest 3600-rpm generator available, with suitable operating characteristics was an 81,250-kva, 80 per cent power factor generator of the hydrogen-cooled type, Fig. 2. As a

[1]Harbor Steam Plant Goes on the Line — Charles P. Garman and W. C. Rowse, June, 1943, POWER PLANT ENGINEERING.

[2]The Spinning Turbine on Power Systems — A. G. Christie, January, 1941, POWER PLANT ENGINEERING.

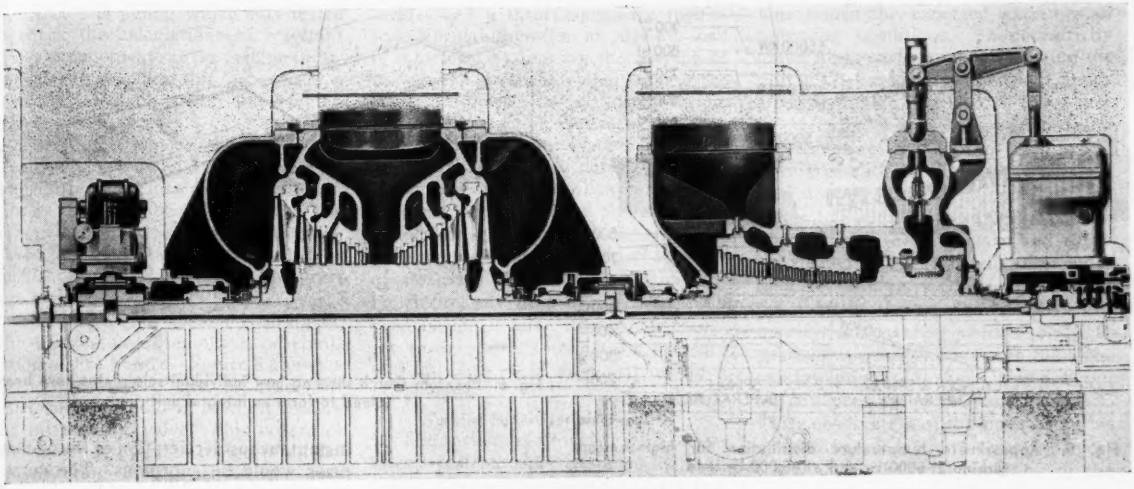


Fig. 3. Longitudinal section of turbine

result, the rating selected was 65,000-kw.

Turbine Blading

The longitudinal section of the turbine is shown in Fig. 3. Steam is supplied through a single throttle valve connected to each end of the steam chest by two steam leads. The high-pressure turbine blading consists of a two-row Curtis wheel followed by 20 pairs of reaction blade rows. Provision is made in this element for three extraction points by dividing the high-pressure turbine.

Steam is led through a crossover pipe, Fig. 4, into the center of a double-flow low-pressure turbine. This turbine has seven pairs of right-hand and seven pairs of left-hand reaction blade rows. Provision for the fourth or lowest pressure extraction point is made between the 4th and 5th stages, these two double flow zones being cored together and the extraction line being carried out through the condenser breeches connection. In addition to the moisture which is removed through this fourth extraction point, further provision for moisture removal is in the form of two water catchers in each end of the double-flow low-pressure turbine. One is located between the 5th and 6th stages and another between the 6th and 7th stages. The last few rotating blade rows are provided with stellite shields for erosion protection.

Two outstanding considerations for the unit were:

(a) The turbine was designed to permit a change in load from 5000-kw to 65,000-kw at the maximum rate of change in steam flow and temperature determined by the boiler characteristics, and

(b) The turbine was designed to withstand shocks resulting from "earth tremors".

Thermal Changes Under Wide Load Changes

A consideration of the thermal changes within the high-pressure turbine cylinder is interesting. The boiler characteristics are such that when operating at the 5000-kw load point, the turbine throttle steam pressure is approximately 1050 psi gage, at a total temperature of 720 F. When the system suddenly calls for full power output, the governor valves, unless otherwise prevented, would assume the wide open position. This sudden increase of load on the boiler would drop both its steam pressure and temperature to such a point that recovery would be unnecessarily retarded. Under the control of a turbine throttle pressure regulator, this pressure may drop to a minimum of 750 psi gage. At this pressure, the predicted minimum steam inlet temperature will be 650 FTT. From this minimum condition of pressure and temperature at the throttle, the recovery of the boiler will be quite rapid until the normal conditions of 850 psi gage, 900 FTT are restored at full load steam flow.

Figure 5 shows graphically the approximate temperature distribution for the high-pressure turbine at 5000-kw, and the final temperature distribution at normal inlet conditions and 65,000-kw load. To insure adequate operating clearances during the severe changes in temperature, special consideration was given to the relative differential radial and axial expansion between the spindle and the cylinder. Since the spindle is a relatively small mass compared to the blade rings and cylinder structure, it was conservatively assumed for design purposes that the spindle reached the temperature levels indicated on the chart for full load operation before there was any change in the temperature of the stationary parts. Under this most adverse assumption, sufficient clearance was provided in the design to insure that there would be no contact between rotating and stationary members.

During the initial run of the unit, extensive differential expansion measurements were taken to establish actual operating clearances during the operations of: (1) warming up, (2) placing on load, (3) picking up maximum load, (4) dropping load, (5) shutting down and (6) cooling off. Readings were taken between the governor end pedestal and the end of the spindle, between the balance piston and the cylinder, between the spindle and cylinder at both ends of the low-pressure turbine and of all axial and transverse expansion movements of the cylinder and pedestal. The readings established the adequacy of the design.

In addition, all the reaction blading has radial clearance with the seal strips sealing against cylindrical surfaces, and as a result of this construction, the efficiency of the blading is the same at all axial positions of the spindle relative to the cylinder.

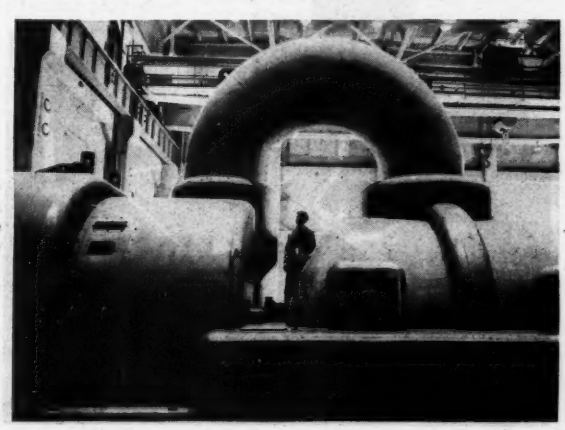


Fig. 4. Crossover pipe leading from high-pressure turbine to double-flow low-pressure turbine

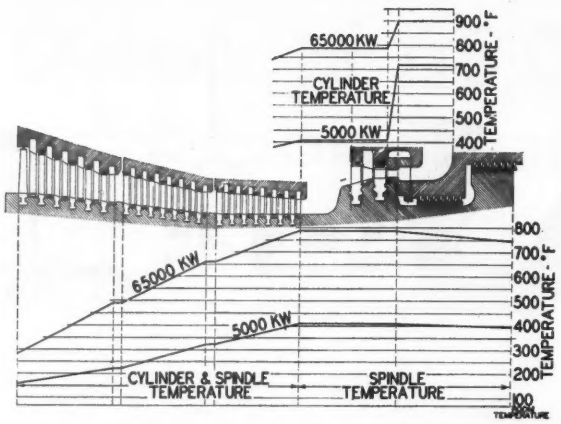


Fig. 5. Approximate temperature distribution for high-pressure turbine at 5000-kw and at 65,000-kw load

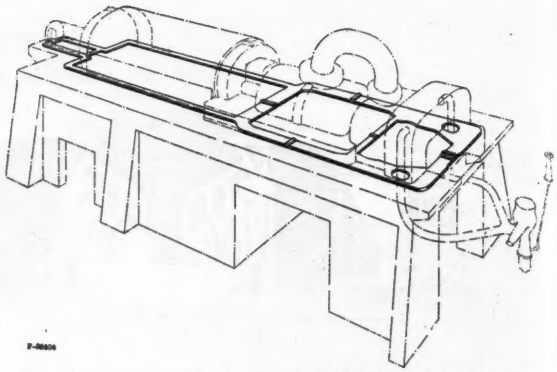


Fig. 6. Phantom sketch showing how individual sole plates have been joined to form an integral unit

Temperature changes as translated to the throttle valve, steam chest, and horizontal joint bolting, present an interesting analysis. It may be observed from Fig. 5 that the inlet steam temperature may vary from 720 FTT to 650 FTT and ultimately back to 900 FTT. This represents a total range of 250 F. The throttle valve and steam chest are designed with sufficient flexibility that the bolts may deflect the walls without any appreciable increase in stress. The design of the throttle valve cover and steam chest cover aids in attaining this end.

At 50,000-kw load, that section of the cylinder surrounding the impulse wheel is at approximately 410 FTT. Upon an increase to rated load, the temperature of the inner wall rises to 780 FTT. On the assumption that the full temperature gradient exists through the wall, the cylinder is designed so that the transient bolt stress is well within the yield point of the bolting material. In addition, the normal relaxation of the bolts after a reasonable period of operation will provide additional margin.

Design relative to the effect of earth tremors was given detail study. Specifications prepared for the machine required that the mechanical parts should withstand the stresses set up by their masses being accelerated in any direction at a rate equal to 0.2 of the acceleration of gravity. The plant was so arranged that the axis of the turbine foundation be located to take best advantage of the existing knowledge of earthquake phenomena. Little, if any, effect is to be expected on the turbine and generator when the resultant motion is lateral or vertical, since the mass of the rotating parts is restrained by the bearings and by gravity in those directions respectively. However, longitudinal motion of the foundation and supporting pedestals may cause an axial movement of the rotating parts relative to the stationary parts. If such motion is experienced, impact will occur after the rotating mass traverses the distance between the thrust collar and thrust shoes. The impact force resulting from the almost instantaneous deceleration of the 60 tons mass would be enormous. The corresponding parts which could be subjected to these forces were designed accordingly.

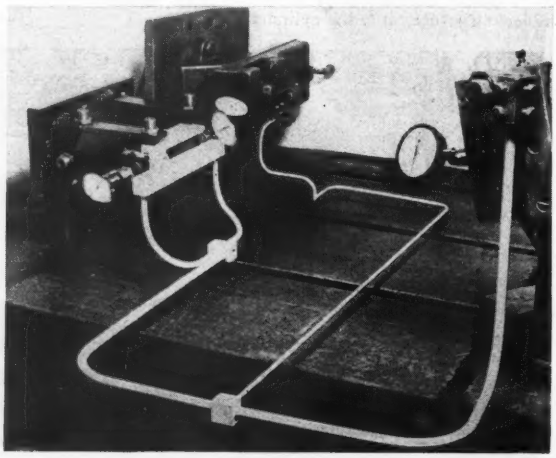
In addition, Fig. 6 shows the treatment given to the sole plates on which, along with the foundation, the alignment of the complete unit depends. The individual sole plates under the generator, the low pressure, and the high pressure turbines were joined and welded together to form an integral unit. By joining the individual members in this manner, the generator frame, the anchor keys under the low-pressure turbine cylinder, and the sliding pedestal support at the governor end of the high-pressure turbine will tend to move as a unit in the case of lateral or longitudinal motion of the foundation.

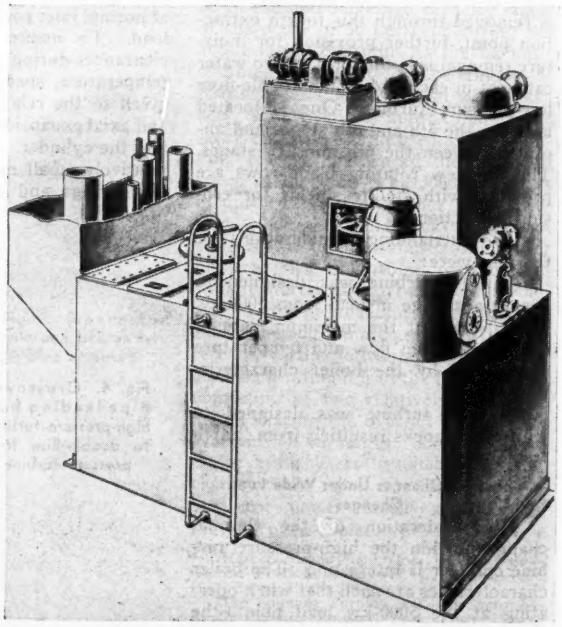
Piping Design by Model

Because of the temperature changes associated with the quick-pickup operation, the steam piping from the boiler to the throttle valve was given careful study by the usual procedure of pipe model test. Figure 7 shows a scale

Fig. 7—Below. Scale model used to check calculations of forces and moments on steam piping

Fig. 8—Right. Perspective sketch of oil reservoir





model of this piping which was tested to check the calculations of resultant forces and moments at the turbine throttle valve. Through this procedure, a perfectly adequate steam inlet piping system was assured.

The foundation for the unit is unusually rugged and is of considerably lower head than normally encountered. This is made possible by the use of two side condensers which are fed through a breeches connection from the conventional bottom exhaust of the low-pressure turbine.

The lubricating system is designed with the customary emphasis on elimination of fire hazard. Figure 8 shows a perspective view of the oil reservoir, which includes built-in twin oil coolers and interchange valve. This construction makes it possible to locate all interconnecting piping within the reservoir.

The control and governing system is provided with a low-frequency governor release and a throttle-pressure regulator. Normal operation at 5000-kw load is controlled by limiting the opening of the governor valves while resetting the speed changer in its full load position. An interconnection between the load limit device and the system frequency permits the load limit device to release the governor valves when the system frequency drops below a predetermined value. The function of the throttle-pressure regulator is to control the flow of steam to the turbine, so that the boiler pressure does not drop below a predetermined value, from which recovery to normal full load steam pressure will be more rapid than with no such lower limit.

Turbine Supervisory Instruments

The turbine is provided with supervisory instruments[3] designed to indicate and record the response of the turbine under the expected extremes of operating conditions. An eccentricity meter gives shaft outage in starting the unit. The cylinder expansion meter gives a graphic record of the response of the cylinder and of support pedestal movement relative to the changes encountered with the changing steam temperature and load. The spindle position meter indicates the relative axial position between the stationary and rotating elements. The shaft vibration meter indicates and records the vibration of the shaft at three points on the unit; namely, at the thrust pedestal or No. 1 bearing, at a location between the high- and low-pressure turbines, and between the low-pressure turbine and generator. Close observation of the supervisory instrument records give an excellent portrayal of the internal condition of the unit during normal operation and during the severe changes in load as anticipated in the design.

[3] Instrument Aids for Turbine Operation—H. C. Werner and G. V. Krenikoff, Nov., 1942, POWER PLANT ENGINEERING.

Centrifugal Pump Control

(*Continued from page* 71)

impulse that to use automatic controls in the future. It is necessary, however, to remember that even certain corrective controls must operate almost instantly, as, for instance, centrifugal boiler feed pump controls intended to maintain a constant level in high pressure boilers.

Difficulty of Operation—Is the application of the control suitable for manual operation or are the forces required to set the control in motion excessive? Taking two extremes for our illustration, it is obvious that while a 1-in. valve can be readily throttled manually, the task of closing or opening a 24-in. valve can be made much simpler if it is provided with automatic electric drive.

Facility of Detection—Is the quantity to be measured subject to accurate determination by human senses or is it impossible to obtain sufficiently accurate measurements except by mechanical means?

Economics of Personnel Attendance—Is an operator always available where needed or does the manual operation of the control require the addition of personnel otherwise not necessary? The best example of this factor is the application of automatic controls to start and stop numerous cellar-drainer or flood protection pumps. The function of the float switches actuating such pumps on level changes at the suction would otherwise require the constant presence of an attendant to start the pump in case of a flood, an occupation rather devoid of frequent labor in most civilized countries.

There may be, in addition, a great number of other factors which apply to individual cases and which must be considered in the ultimate decision between manual, semi-automatic and fully automatic control operation. This, incidentally, is a suitable occasion to dispel the rather popular misconception that once automatic operation is provided, all manual control is precluded. Not only can most automatic controls permit manual operation, but it is very important that the installation be always provided with a means to switch from automatic to manual operation, at least insofar as the measuring, impulse and relay elements are concerned.

Pilot Devices

It may be of some interest to note that a great number of automatic controls are electrically operated so that while the measuring elements may be mechanical or hydraulic, the impulse and relay elements are based on electrical contacts and transmission or interruption of electrical currents. Such automatic controls are principally directed at the interruption or resumption of flow, based on level or pressure fluctuation. Because the currents involved in the operation of the pump drivers are generally excessive for the control apparatus, the latter serve as pilot devices.

A complete description of all the possible automatic electrical controls would be too extensive for inclusion in these articles, but Figs. 3 and 4 may be used to illustrate two typical pilot devices. The first, on Fig. 3, shows a float switch used in the control circuits of a-c or d-c automatic starters. The switch is arranged for tank operation, closing as the lower liquid level is reached and opened as the level approaches a predetermined top value. This action may be easily changed for sump operation by interchanging the float and counterweight. Then the pump would be caused to start up at the high level and to stop when the sump would be drained to its low level.

The pressure governor in Fig. 4 is used as a pilot device for automatic starters of centrifugal pump motors. The location of the adjustable contacts (A) determines the pressure at which the motor is started or stopped. The movable contact (B) moves between the adjustable contacts which can be set for the minimum cutting-in pressure and maximum cutting-out pressure. Frequently a pressure gage (E) is incorporated for the convenience of the operators. A relay coil (C) and relay contacts (D) are arranged to operate the automatic starter.

Now that the fundamental control functions and the analysis of the controls themselves into their component elements have been described, centrifugal pump controls in some typical and specific applications will form the subject of the following article in this series.

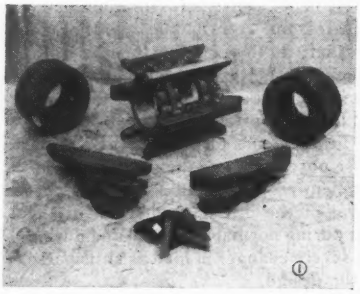
(*To be continued*)

A RECENT news-reel showed three mechanical cotton pickers waddling down long rows of cotton plants on a Southern plantation, sucking in the white-topped stalks and leaving them standing behind the picker stripped of their cotton. Caldwell in The Chicago Sun indicates that after the war International Harvester, Allis-Chalmers and John Deere may produce mechanical cotton pickers in volume, also that Graham-Paige will have a "fire-spitting" cultivator that in one operation will kill weeds for three years.

RESEARCH IN ACTION is the title of a 58-page bulletin recently issued by Battelle Memorial Institute, Columbus, Ohio, describing in words and pictures the various ways in which it conducts research for industry. The bulletin is a beautiful job of typography and printing, the photographs of its various operations, showing the staff conducting their various projects, being especially good. The bulletin outlines the institute's organization, men and methods, then describes in detail its research work in minerals, fuels, foundry practice, forming of metals, nonferrous metallurgy, alloys and heat treatment, high temperature metals, ceramics, electro-chemistry, physics and production.

An Electric Generator Is Built

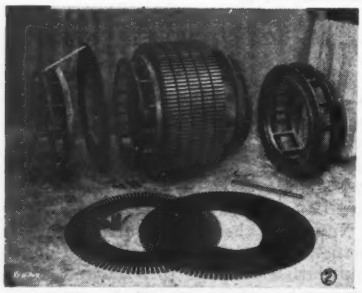
Out of metals, fiber, resin and carbon, skilfully cast parts, shaped, machined and assembled through the use of accurate tools in the hands of expert workers, comes a continuous stream of 250 kw, 3-wire, marine type direct current generators to be driven by Diesel engines applicable for use on land or sea

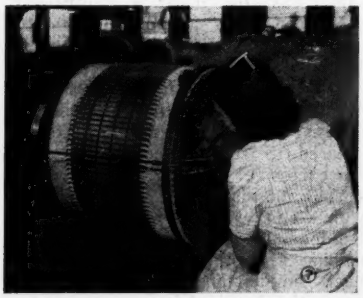


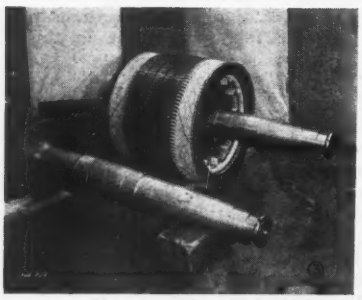
A thorough appreciation of the importance of exacting detail is obtained by an engineer as he watches the making of elementary parts and their assembly into the rotor, the stator and finally the completed direct current generator as it goes on test. The photographs presented here were chosen to simulate, as nearly as possible, a trip through the Ridgway shops of Elliott Company where such work is in progress. The trip proceeds according to the numbers on the illustrations.

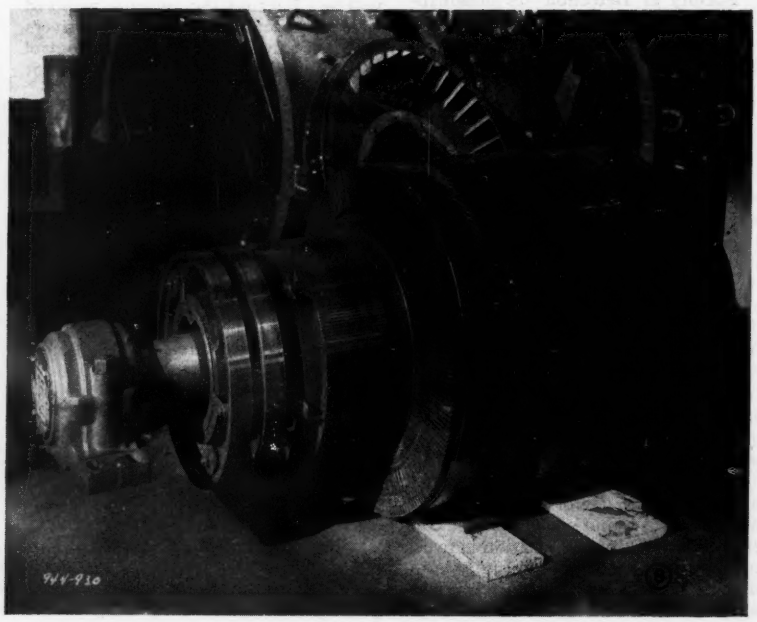
1. Note the husky individual parts that welded together make up the completed spider shown in center of photograph.

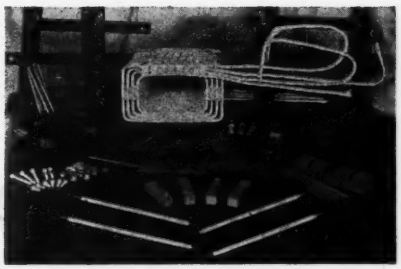
2. Hundreds of electrical steel laminations fit together perfectly over the











spider and are held solidly in place by end clamping plates.

3. The forged shaft with integral flange is accurately ground to size at the fits.

4. Prior to the stacking of alternate copper bars and mica strips, every effort is extended to make sure that each bar is perfectly flat for a positive fit, an essential for perfect commutation.

5. The commutator bars and risers are assembled on accurately machined shells and insulated with mica strips and "V" rings. Complete commutator shown at upper left.

6. Commutator sections are arranged in a mold prior to placing in furnace. In this photograph, the copper is being cut away from the mica under a magnifying glass to prevent shorting.

7. The commutator risers and windings are silver soldered together to assure a permanent connection.

8. The quality of workmanship is reflected in this excellent photograph which shows the most minute details of the armature.

9. The brush rigging consists of an assembly of parts, each one as accurately built as the machine itself.

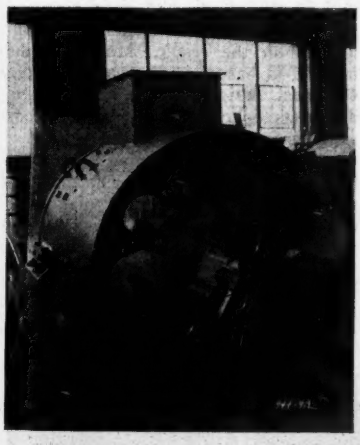
10. The field frame assembly viewed from the commutator end. Simplicity of design, clean, neat and careful workmanship are certainly depicted here.

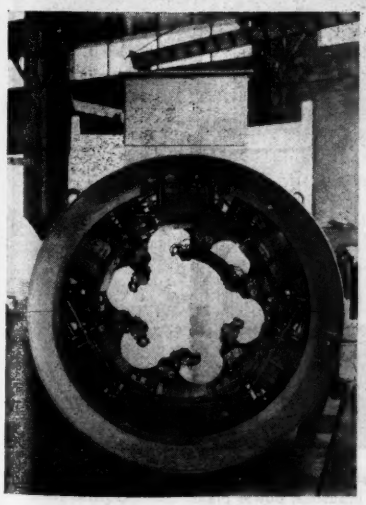
11. A full view, from the coupling end close up, verifies this even more so.

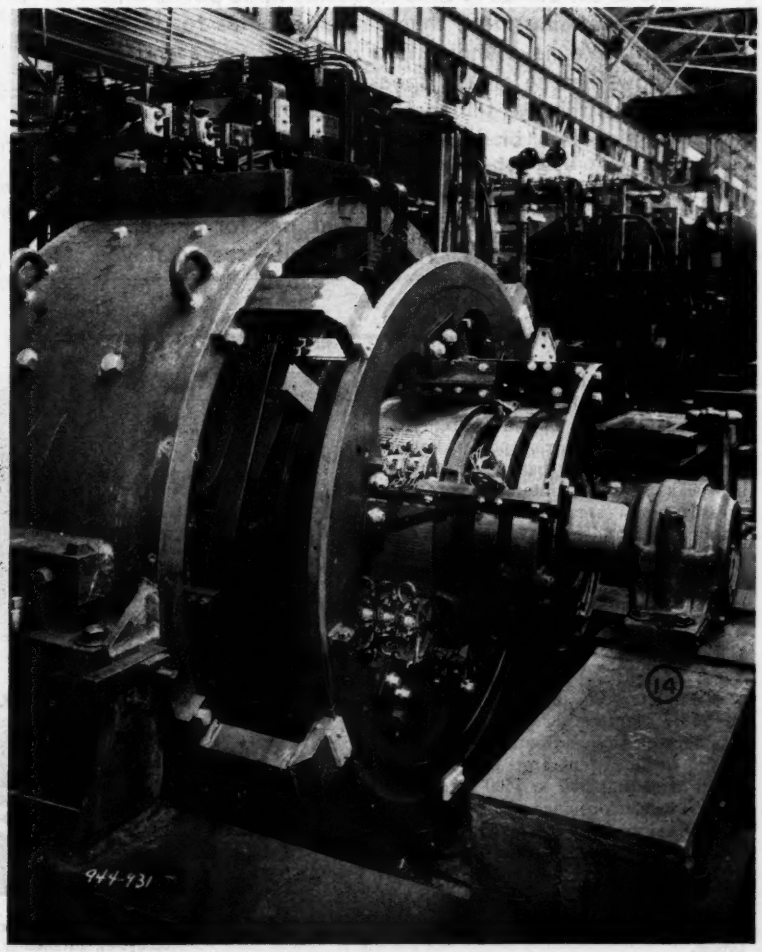
12. With terminal box, drip cover and end bell removed, a connection diagram could almost be made from this simple and orderly arrangement of coil connectors.

13. The balance coil parts have been just as carefully selected and tested as the generator itself. Here again expert workmanship is apparent.

14. Each generator is completely and carefully tested in the presence of an inspector. Drip shield and terminal cover removed to facilitate making connections and for viewing operation under all load conditions including specified overloads.







MODERN EXTRACTION TURBINES*

Part II. Estimating the Performance of Single Automatic Extraction Condensing Steam Turbines

By L. E. NEWMAN
Turbine Division, General Electric Company
Schenectady, N. Y.

Were WE surprised! And How! Lou Newman told us that the second article in this series would enable us to estimate the performance curve of an automatic extraction turbine from only three points without spending more than fifteen minutes to do the job. We have known Lou for many years and we know that he always speaks the truth but when he told us this, we felt that he was just a bit over optimistic—two or three hours or so. But we were wrong. We tried it, and on our second attempt, produced a completed performance chart in 14 minutes, 35 seconds. We think par for us will be about ten minutes. Try it yourself—see what you can do it in.

IN THE FAMILY of extraction turbines the single-automatic extraction steam turbine is Cinderella. Its chores in the industrial power house range from carrying base load to taking peaks; from maintaining constant pressure in a steam process line, to acting as a stand-by for a noncondensing turbine. Of all types of automatic extraction turbines it finds the widest field of application; it is easiest to apply of all extraction turbines; and, of most interest to us in this article, its performance is easy to estimate.

Complete on these pages is a method for estimating quickly the performance of single-automatic extraction steam turbine generator sets in the range of ratings 500 to 7500 kw inclusive. The performance chart for such a turbine may be obtained by estimating only three points, and then adding the limits to the chart. With a little practice the performance chart for any turbine within the range of this method can be drawn, starting from scratch, in 15 minutes or less.

The method is an empirical one that is based on the principle of estimating accurately the factors that influence greatly the result, and approximating roughly the factors that have little influence on the result. Moreover, the method is based on a turbine of conventional design that is expected to divide its operating time over periods ranging from no extraction to full extraction, and loads varying from light loads to full load. As such, the estimates will be in the proper magnitude for preliminary studies. It should be understood, however, that turbine designs are flexible, and performance under one condition can be favored at the expense of a less frequently occurring operating condition. Thus, it is

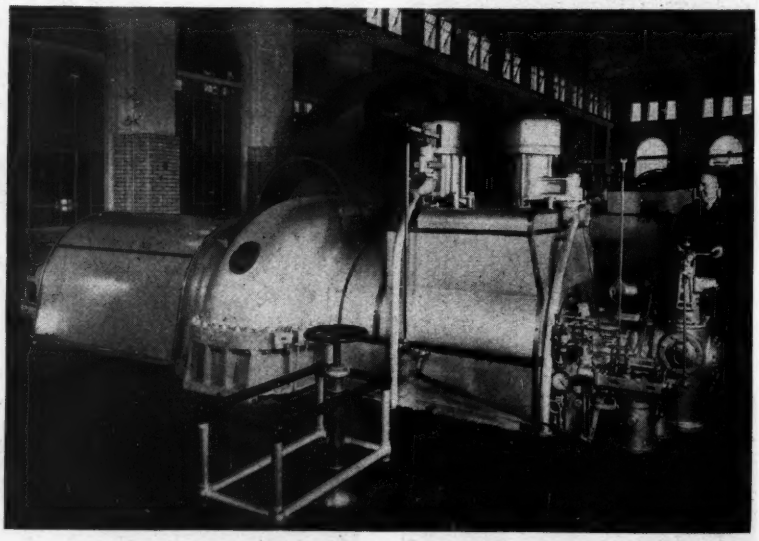


Fig. 1 G-E Condensing single-automatic extraction steam turbine generator set, 4000 kw, 60 cycles, installed in an industrial power plant

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STEP BY STEP METHOD

for determining performance of single-automatic extraction condensing steam turbines driving 50 or 60 cycle generators.

CALCULATIONS

TSR_1 = *7.60* lb per kwhr = Theoretical Steam Rate, from throttle to exhaust (Table 1)
TSR_2 = *13.3* lb per kwhr = Theoretical Steam Rate, from throttle to extraction (Table 1)
Efficiency = *0.70* (Table 2)

A = Full load nonextraction throttle flow $= \dfrac{TSR_1 \times \text{Rated Output}}{\text{Efficiency}} = \dfrac{7.60 \times 4000}{0.70} =$ *43,400* lb per hr

B = Half-load nonextraction throttle flow = A × half-load flow factor (Table 3) = *43,400* × *0.575* = *25,000* lb per hr

$\dfrac{TSR_1}{TSR_2} = \dfrac{7.60}{13.3} =$ *0.57*

E = Extraction factor = *0.52* (Chart 2)
F = Max. required extraction flow = *50,000* lb per hr
C = Full-load throttle flow at max. required extraction flow = A + (E × F) = *43,400 + (0.52 × 50,000)* = *69,400* lb per hr
S = Min. flow to exhaust = *2800, or nearest 500 lb* = *3,000* lb per hr (Chart 3)
M = Max. permissible throttle flow = *250,000* lb per hr (Chart 4)

HOW TO DRAW PERFORMANCE CHART

Plot points A, B, and C, and draw the straight lines indicated by Chart 1 ***(the example is plotted on Chart 5)***. Add the limits:

The min. flow to exhaust limit is a straight line passing through the point on each line of constant extraction flow where the throttle flow is equal to the extraction flow plus the minimum exhaust flow (S).

The max. flow to exhaust limit is a straight line passing through the point on each line of constant extraction flow where the throttle flow is equal to the extraction flow plus the full-load nonextraction throttle flow (A).

The max. throttle flow limit may be chosen at any value not in excess of the max. permissible throttle flow (M), nor in excess of a flow equal to 3 times the full-load nonextraction flow (3 × A). It is usually taken as approx. equal to the full-load throttle-flow at max. required extraction (C).

possible to design a turbine so as to be very efficient when operated at high extraction flows, but such a turbine will not be as efficient at low extraction flows as one designed for high efficiency at low extraction flows.

The charts and tables spread over these pages make the method look more complicated than it is. Perhaps the simplicity of the method will be better realized if it is understood that Tables 1, 2, and 3, with Charts 1 and 2, comprise the entire estimating method. Charts 3 and 4 are simply limits that are not to be exceeded, and Chart 5 is a completed Performance Chart.

The STEP-BY-STEP METHOD with Chart 1 includes all of the instruction needed to prepare preliminary performance charts for single-automatic extraction condensing turbine generator sets. In order to make the method clear, a performance chart will be estimated (Chart 5) for a unit rated:

4000 kw—0.80 pf—5000 kva—60 cycle—condensing, single-automatic extraction steam turbine generator set.

Steam Conditions:

Main pressure .....400 lb/sq in. G
Initial temperature ....700 F
Exhaust pressure .....2" Hg abs
Extraction pressure ....10 lb/sq in. G
Max. extraction flow...50,000 lb/hr

All of the calculations needed to prepare the performance chart for this turbine are shown in italics on the STEP-BY-STEP METHOD. It will be of interest to follow this through.

Theoretical Steam Rates (Table 1)

The theoretical steam rates given in Table 1 are based on representative initial steam conditions. Inasmuch as each column is headed by both an initial pressure and an initial temperature, this condensed table is not well suited to interpolations.

Table 1. Condensed Table of Theoretical Steam Rates*

Main Pressure, in lb./sq. in. G...	150	200	250	300	400	600	850
Initial Temperature, deg. F.....	450	500	550	600	700	750	825
Initial Superheat, deg. F.....	(84)	(112)	(144)	(178)	(252)	(261)	(298)
EXHAUST PRESSURE	THEORETICAL STEAM RATES, IN LB./KW.HR.						
1 in. Hg. abs.....	9.09	8.54	8.10	7.71	7.06	6.63	6.19
2 in. Hg. abs.....	9.98	9.32	8.79	8.34	7.60	7.09	6.58
3 in. Hg. abs.....	10.62	9.87	9.28	8.78	7.96	7.40	6.85
0 lb./sq. in. G.....	18.2	16.1	14.6	13.4	11.7	10.4	9.31
10 lb./sq. in. G.....	22.4	19.3	17.2	15.6	13.3	11.6	10.30
20 lb./sq. in. G.....	26.7	22.3	19.5	17.5	14.7	12.7	11.10
50 lb./sq. in. G.....	42.4	32.3	26.8	23.1	18.5	15.4	13.10
100 lb./sq. in. G.....	...	58.1	42.5	34.1	25.1	19.4	15.90
150 lb./sq. in. G.....	...	...	...	51.1	33.6	23.8	18.60
200 lb./sq. in. G.....	...	...	...	...	45.8	29.0	21.50
250 lb./sq. in. G.....	...	...	...	...	...	35.3	24.80

*From "Theoretical Steam Rate Tables" by Keenan and Keyes, published in 1938 by ASME.

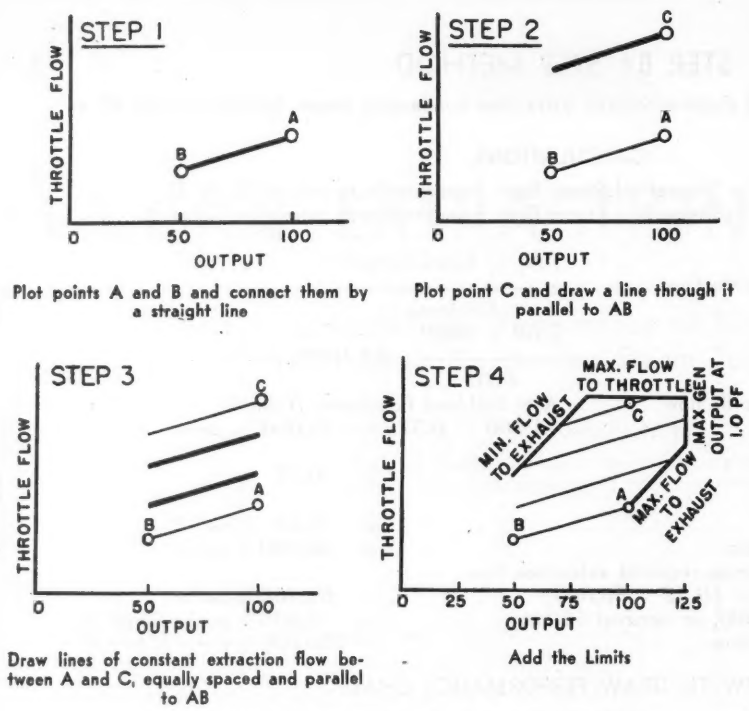

Chart 1. Step-by-step Method of Constructing Performance Chart

Where steam conditions are other than those shown in this table, the theoretical steam rates may be derived from a Mollier chart,[1] or read directly from a comprehensive set of theoretical steam rate tables such as those by Keenan & Keyes, published by the A.S.M.E. in 1938.

Care should be used in determining the theoretical steam rates; they are factors that influence greatly the result.

Efficiency (Table 2)

This table gives an approximation of the full-load efficiency with no extraction for single-automatic extraction condensing turbines. The efficiencies taken from this table are in the proper magnitude but may be higher or lower than the actual performance guarantees for a specific turbine. If, for example, a turbine were designed to favor performance at high extraction flows, it is probable that the performance guarantees for such a turbine at full load with no extraction would be somewhat poorer than the efficiencies estimated in Table 2. In most cases, regardless of design, the error for efficiencies read from this table will be less than 5 per cent.

Half-Load Flow-Factor (Table 3)

The half-load flow-factors in Table 3 are approximations that assume that the throttle flow versus output curve at no extraction will be a straight line. The table assumes, too, that all turbines of the same rating, regardless of design, will have the same half-load flow to full-load flow relationship. Obviously this relationship is not a constant one, but the error introduced by this assumption is not appreciable provided the performance chart is not extrapolated below one-half load.

Extraction Factor (Chart 2)

The ratio of theoretical steam rates (TSR_1 to TSR_2) is an empirical measure of the extraction factor. This relationship, and the assumption that all extraction charts are made up of straight lines, parallel to each other and equally spaced, makes possible this estimating method. Such an assumption introduces an error which is more than compensated for by the simplicity it makes possible in the estimating method.

The extraction factor is the portion of a pound of steam which must be added to the throttle flow for each pound of steam extracted. Its use is shown in the example.

Max. Required Extraction Flow (F)

The maximum required extraction flow is part of the given conditions for each application of an extraction turbine. No problem is presented by this flow when it is small, but sometimes the desired extraction flow is beyond the turbine's capacity. In such a case the maximum throttle flow limit line (discussed under the heading "Max. throttle flow") will cut off the maximum extraction at the point where full-load is developed with minimum steam flow passing to the exhaust section.

When selecting a flow for the maximum required extraction flow (point F), it will be found desirable to pick a number easily divisible into smaller flows. This is apparent on Chart 5 where the 50,000 lb per hr flow has been divided into flows of 10, 20, 30, 40, and 50,000 lb per hr for convenience in reading the chart.

[1]Thermodynamic Properties of Steam, by Keenan and Keyes, John Wiley & Sons, Inc., N. Y., 1936.

Table 2. Full-load Non-extraction Efficiencies for Condensing Single-automatic Extraction Steam Turbines

Rating, in kw at 0.8 pf	Main Pressure, in lb./sq. in. G. 150	200	250	300	400	600	850
	Efficiency						
500	.600	.595	.585	.580	.565	.545	...
625	.615	.610	.605	.600	.580	.560	...
750	.630	.625	.620	.610	.595	.575	...
1000	.650	.645	.640	.630	.620	.600	...
1250	.665	.660	.650	.645	.635	.615	...
1500	.675	.670	.665	.660	.645	.630	...
2000	.690	.685	.680	.675	.665	.645	...
2500	.700	.695	.690	.685	.675	.660	...
3000	.710	.705	.700	.695	.685	.670	...
3500	.715	.710	.705	.700	.690	.680	...
4000	.720	.715	.710	.705	.700	.685	...
5000	.725	.720	.715	.710	.705	.695	.685
6000	.735	.730	.725	.720	.715	.705	.695
7500	.740	.735	.730	.725	.720	.715	.705

Table 3. Half-load Flow Factors

Rating in kw at 0.80 pf	Factor
500, 625, 750	0.590
1000, 1250, 1500	0.585
2000, 2500, 3000	0.580
3500, 4000, 5000	0.575
6000, 7000	0.570

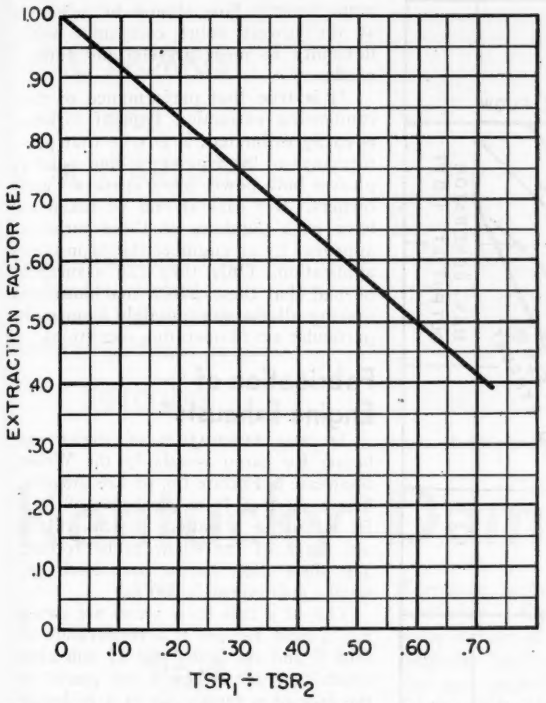

Chart 2. Extraction Factor versus Ratio of Theoretical Steam Rates

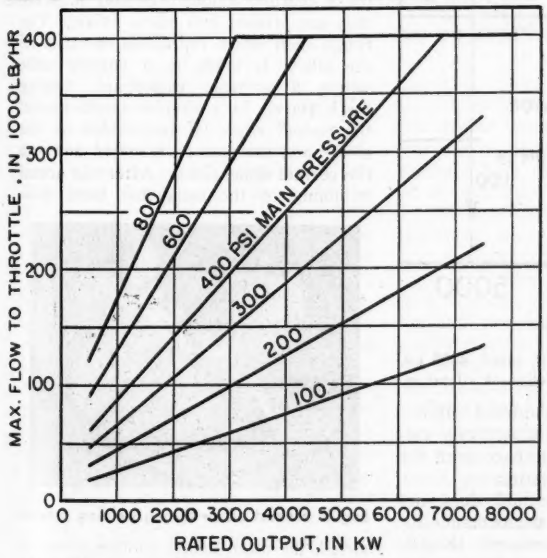

Chart 4 (Left) Maximum Throttle Flow versus Rated Output. Estimates should be limited to those coming within the maximum throttle flows shown on this chart

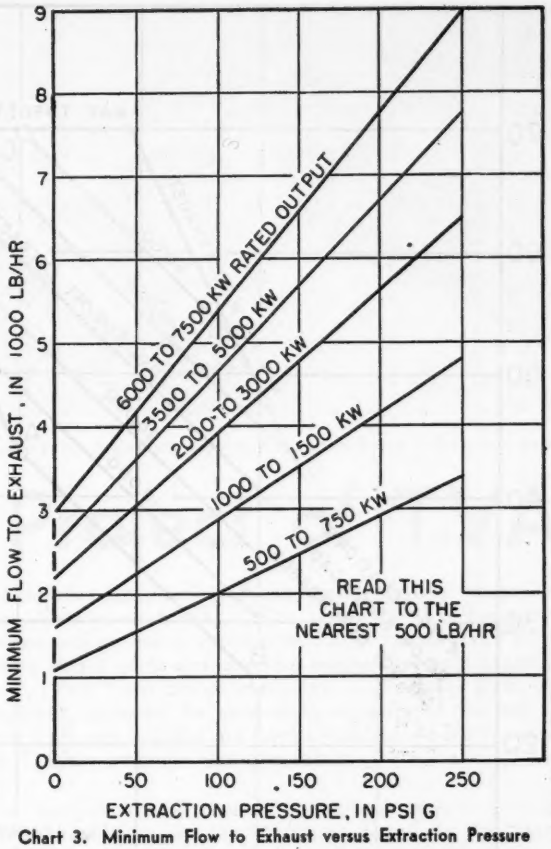

Chart 3. Minimum Flow to Exhaust versus Extraction Pressure

Minimum Flow to Exhaust (Chart 3)

The chart of minimum flow to exhaust is plotted against extraction pressure with lines for different turbine ratings. It is not necessary to read this chart more closely than the nearest 500 lb per hr.

The minimum steam flow to exhaust is fixed either by the minimum safe flow needed to cool the exhaust stages, or by the minimum flow that will leak around the shaft and through the extraction control valve under its closed condition.

Chart 1 gives the steps necessary to prepare the performance chart up to the point where limits are added.[1] The first limit usually added to such a chart is the limit of minimum flow to exhaust, some times called the limit of maximum extraction inasmuch as it acts to limit maximum extraction. To add this limit to the chart, two or three points should be plotted on the lines of constant extraction flow where the throttle flow is equal to the extraction flow plus the minimum exhaust flow. Thus, on Chart 5, with a minimum exhaust flow of 3000 lb per hr, the point on the 50,000 lb per hr limit line will be at 53,000 lb per hr throttle flow; at 40,000 lb per hr extraction, the throttle flow will be 43,000 lb per hr; and, if the 30,000 lb per hr extraction line were extended it would meet an extension of the minimum flow to exhause limit line at 33,000 lb per hr.

When placing limits on an extraction chart, it is helpful to recall that the flow through the high pressure section is the throttle flow; and that flow to exhaust is equal to the throttle flow minus extraction flow.

Maximum Flow to Exhaust

The maximum flow to exhaust limit is added to the chart in exactly the same manner as the minimum flow to exhaust limit was added. In this estimating method the assumption has been made that all turbines will be designed with exhaust sections sufficiently large to enable the turbine to carry full rated output with the extraction pressure held constant but no extraction taken from the turbine. This is the usual practice with condensing extraction turbines, although cases are occasionally encountered when it is better to make the exhaust section larger or smaller than the general rule.

In adding the maximum flow to exhaust limit, the lines of constant extraction flow should be extended to the point where they are cut off by this limit or by the limit of generator output. Thus, on Chart 5, the 10,000 lb per hr extraction flow line is cut by the limit at a throttle flow of 53,400 lb per hr (10,000 lb per hr plus point A), but

[1]Extraction turbine performance charts with their limits are discussed in more detail in "Modern Turbines," by Newman, Keller, Wales, and Lyons. John Wiley & Sons, Inc., N. Y. 1944.

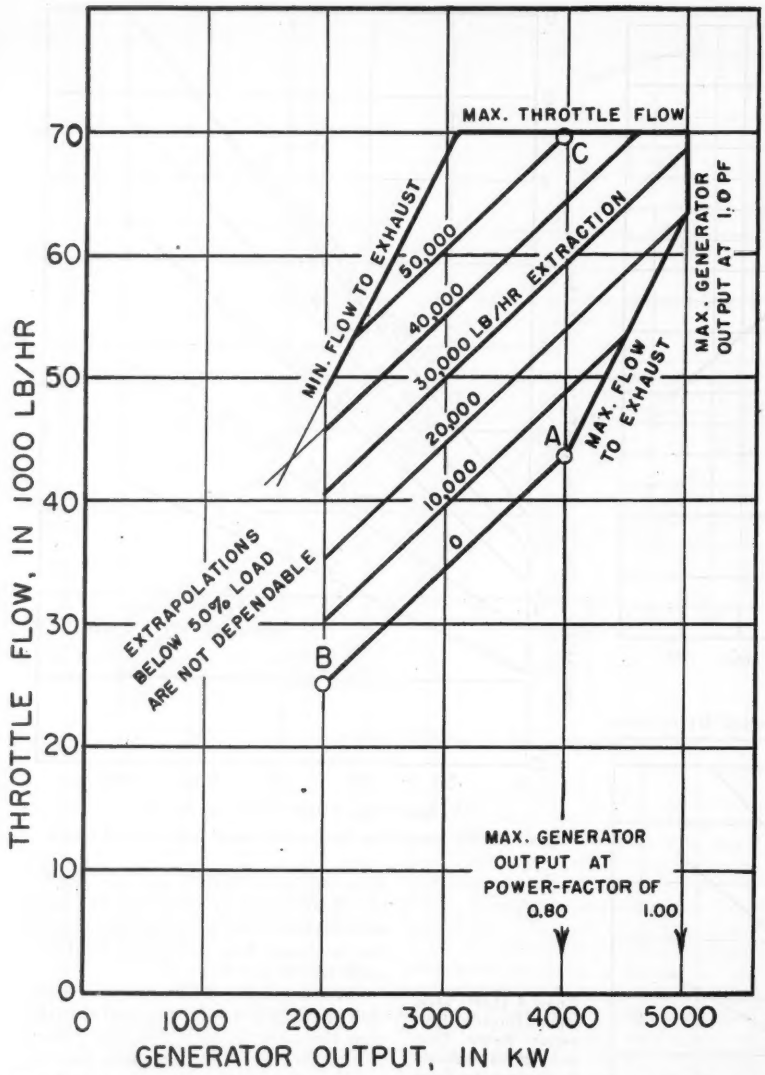

Chart 5. Throttle Flow versus Output Performance Chart for example unit, rated, 4000 kw. Steam conditions: 400 psi, g, 700 F, 2 in. Hg, Abs, with automatic extraction at 10 psi, g.

the 20,000 lb per hr extraction line is cut off by the limit of generator output, 5000 kw at 1.0 power factor.

Maximum Generator Output

The usual turbine generator set has an 0.80 power factor generator, and a turbine capable of carrying full kva on the generator at 1.0 power factor. This is indicated as 125 per cent capacity on Chart 1, and as 5000 kw at 1.0 power factor on Chart 5.

Maximum Throttle Flow (Chart 4)

The maximum throttle flow from Chart 4 is not a true limit in the sense that turbines of the ratings shown could not be built for higher steam flows. Rather it is intended as a warning that such a turbine would be of special design. So also is the limit imposed by a throttle flow equal to three times the full-load non-extraction flow (ie 3 x A). Both of these maximum throttle flow limits are exceeded by many actual extraction turbines, but performance of such machines is outside the range of this method. These limits will not be encountered often—when they are, a manufacturer's turbine specialist should prepare even the most preliminary of estimates.

This estimating method does not indicate any change in performance for differences in the maximum throttle flow alone. Actually, performance under a given condition will be better if the turbine is designed for a flow no greater than that required to meet the particular condition than if the turbine is designed for a flow much greater than needed. If, for example, performance Chart 5 had been estimated for 70,000 lb per hr extraction flow, the estimated throttle flow at 50,000 lb per hr extraction would remain unchanged, on the basis of this method. In an actual turbine, performance would be better for a turbine designed and operating at 50,000 lb per hr extraction, than for a turbine otherwise the same except designed for 70,000 lb per hr but operating at 50,000 lb per hr extraction. Because of this, the maximum throttle flow should be selected at the lowest value consistent with flexibility to meet present and future needs.

It is true that performance of the condensing extraction type of turbine is easily estimated; it is true that performance of his type of turbine usually pleases both power plant operators and owners. But care should be taken to have each purchase of these turbines approved by an engineer skilled in their application. Only then can assurance be had that these useful machines are making all the gain possible from each particular set of operating conditions.

Fabrication of Engine Exhausts*

IN THE FABRICATION of engine exhausts for cargo vessels by the Weber Showcase & Fixture Co. of Los Angeles, first a sheet of ⅜ in. steel plate, 9 by 6 ft, is cut to a pattern which will fit one shape of the elbow to be formed. The sheet, after having been torch cut, weighs approximately 300 lb.

One at a time these pieces are swung into a blast furnace at a temperature of 1400 F and are heated for 15 min after which they are removed and placed on the face of a female die of a hydraulic press nearby. Under 400 tons pressure they are pressed into elbow valves. The rough shell which represents one-half of the elbow is taken to a cutting table where a portable radiograph cutting torch travels in a circular track around the curved edges of both sides of the metal, and the piece is trimmed down to the correct dimensions. After the actual trimming of the metal has been completed, the torch makes another complete trip and mitres the edges for welding the two halves together.

Engine exhaust elbow during welding process

Joining the two halves is done with arc welding, but the method used to clamp and draw the edges to be welded into position is somewhat unusual. After preliminary tacking of the two halves together, two small brackets are welded on either side of the seam and a push-pull, screw type jack is fastened on these brackets and the seam drawn into a snug position where it is firmly held until the welding is completed.

Two welding necks are installed at each end and the 25 in. diameter welded elbow is completed and ready for installation.

* Data and Photo, Courtesy The Hobart Brothers Co., Troy, Ohio.

C. L. NORRIS
and
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Senior Mechanical Engineers
Design Department
Tennessee Valley Authority
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describe

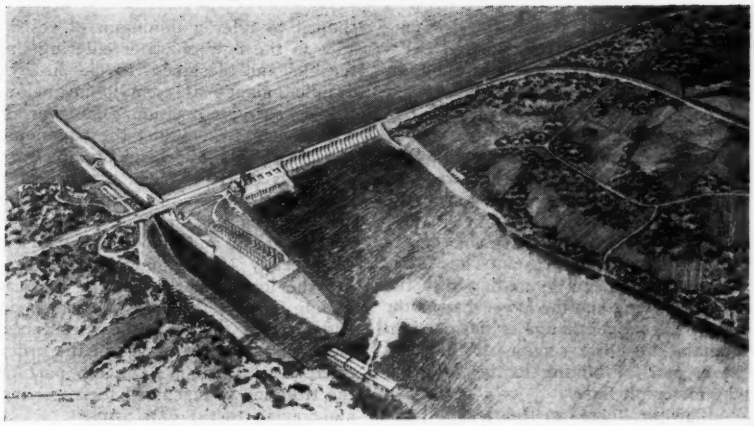


Fig. 1. Artist's general view of Kentucky Dam, showing locks, power house, spillway and dam

Kentucky Dam Project of TVA

Part I

Complete technical details of hydraulic turbines, governors and mechanical auxiliaries in Kentucky Dam power house . . . This article, Part I of two parts, gives details of turbine and generator construction, draft tubes, speed rings, propeller type runners, wicket gates and governor mechanism, both construction and operation . . . Part II will discuss auxiliaries . . . Kentucky Dam, last link in TVA development, designed for generating capacity of 160,000 kw in five units . . . Four units now installed are Kaplan turbines, 44,000 hp each, driving 35,000 kva, 13,800-v umbrella-type generators

KENTUCKY DAM, the last of the main-river plants to be built by the Tennessee Valley Authority, is located in Marshall and Livingston Counties in Kentucky on the Tennessee River, 22.4 miles above the confluence of the Tennessee and the Ohio Rivers. The dam was closed on August 30, 1944, and completes the conversion of the Tennessee River's 650-mile course from an uncontrolled liability to an outstanding asset. The river is now a continuous chain of nine lakes, the largest of these by far being the Kentucky Lake. The lake, which is approximately 184 miles long and has about 250 square miles of surface with approximately 2200 miles of shoreline, provides a controlled flood storage capacity of approximately 4,000,000 acre feet.

The dam is a maximum of 206 ft high and approximately 1.6 miles long. The normal head on the power plant is 51 ft, and the maximum head is 59 ft. The normal minimum expected head is 20 ft; however, during floods the head due to high tailwater may be reduced to 6 ft. The power house, which is designed to contain five generating units having a total plant capacity of 160,000 kw, is located on the right bank of the river adjacent to the spillway section of the dam. Due to its scope, the completion of Kentucky Dam comprises one of the major feats in the annals of dam building.

Turbines Are Adjustable Propeller Type

The initial power installation at Kentucky will consist of four hydraulic turbines of the Kaplan or adjustable propeller type. The embedded parts of the fifth unit will be installed in the power house substructure for stability as a factor of safety against extremely high tailwater which prevails at this plant during flood seasons. Each of the four turbines installed is rated 44,000 hp under 48 ft head at 78.3 rpm and is direct-connected to an umbrella-type generator which is rated 35,000 kva, 3 phase, 60 cycles, 13,800 v. The turbines are designed to produce maximum efficiency when delivering 44,000 hp under the normal head of 51 ft and are guaranteed to deliver 10,500 hp under a head of 20 ft. Figure 2 shows a cross-section through one unit.

Each turbine is connected to the forebay through rectangular water passages of comparatively short length, the distance from the center line of the unit to the upstream face of the intake structure being 67 ft. Each intake is composed of three passages through the dam section, with each section containing two gate slots. The upstream or service slots contain the intake trashracks, and the downstream slots contain the permanent intake gates. The center gate is equipped with rollers while the two outside gates are of the sliding type. With a discharge of 10,500 cfs through a turbine, the velocity through the trashracks is 6 ft per sec, and the velocity at the scroll case entrance is 5 ft per sec. The spiral scroll cases are concrete and of rectangular sections. The draft tubes are of the elbow type and are fitted with gates and filling and unwatering facilities, described later in this article. The bottom of the draft tubes is 57 ft below the center line of the distributor, which is set at elevation 300.00.

Embedded Turbine Parts

The embedded parts of the turbines are of conventional design and consist of the draft tube liner, the discharge ring, the speed ring, and the upper and lower pit liners. The draft tube liner has an over-all height of 20 ft 6 in. and an outside diameter of 27 ft 8 in. It is composed of steel plate, shop- and field-welded, and is heavily ribbed on the outside for embedding in the surrounding concrete. The liner forms the top part of the draft tube and is formed so that the continuity of the design shape of the draft tube is held throughout its entirety. The top of the liner ends in a connection designed for welding to the lower flange of the throat ring.

The throat or discharge ring has an over-all height of 7 ft 7 in. and an over-all diameter of 29 ft. It is formed from heavy steel plate, welded, and is fabricated in two half-sections, flanged, and designed for bolting together during erection. The interior is spherically bored to a diameter of 21 ft 8 in., which provides a clearance of 3/16 in. between the tip of the runner blades and the face of the ring. The bottom flange is recessed to receive the top of the draft tube liner, and the top flange is machined and drilled for receiving the lower distributor ring and the speed ring. The whole discharge ring is heavily ribbed and braced on the outside to ensure a true surface adjacent to the runner vanes.

The cast-steel speed ring is composed of six sections having an over-all diameter of 33 ft 10 in. and an over-all height of 13 ft 4 in., with a guide case height of 8 ft 4 in. The castings contain 12 stay vanes shaped to offer a minimum of resistance to the flow of water entering the turbine. The vanes are designed to carry the entire load imposed by the weight of the concrete, the turbine, the generator, and water thrust. The lower flange is machined for mating with the discharge ring and the lower distributor ring. The upper flange is designed to contain the outer section of the head cover and for bolting to the flange of the lower pit liner.

The pit liners are fabricated from welded steel plate, ribbed on the outside, and flanged on the bottom for bolting to the speed ring. The lower liner contains the foundation for the two turbine servomotors. The upper liner is designed for a welded connection to the top of the lower liner. The outside of the liners is fitted with perforated channels and drain piping for collecting seepage water from the scroll case. The combined liners have an over-all diameter of 30 ft 5 in. and an over-all height of 16 ft 4 in.

Internal Turbine Parts

The fixed internal parts of the turbine consist of the lower distributor ring, the outer and inner head covers, the head cover barrel, the wicket gates, the gate ring assembly, the wicket gates servomotors, and the turbine guide bearing.

The lower distributor ring is a steel casting in two half-sections containing the bronze bushings for receiving the lower part of the wicket gate trunnions. It is machined and drilled for connecting to the discharge and speed rings and is shaped to form a continuous and smooth surface with those parts.

The inner and outer head cover pieces are steel castings, each formed in half-sections and designed for bolting together during assembly. The outer cover is machined and drilled for bolting to the speed ring and the inner cover. It also contains the bronze bushings for the upper part of the wicket gate trunnions. The inner cover is flanged and machined for bolting to the outer cover and the head cover barrel. It is also machined on top to receive the gate ring. The combined covers are designed to carry the weight of the turbine runner and shaft assembly. The head cover barrel bolts to the lower flange of the inner head cover and is bored inside to receive the guide bearing housing. The bottom flange of the barrel is fitted with a bronze wearing strip and seal ring designed to take the upward thrust of the runner when motoring in water and to limit the flow of lubricating water through the guide bearing.

Wicket Gates

The 24 wicket gates are made from integral steel castings, which are shaped to offer a minimum of resistance to the flow of water entering the turbine and designed to be in hydraulic balance at some point below 30 per cent gate position. The over-all wicket height, including the trunnions, is 12 ft 3¾ in. The height of the gate proper is 99.910 in., which provides a total clearance top and bottom of 0.090 in. The trunnions are 7 in. in diameter and are drilled and tapped for receiving extra-heavy ¾-in. piping for lubricating the lower bearings. The vertical sealing faces of the gates are machined and ground so that the clearances, under 300-lb pressure, are in the order of zero to 0.004 in. The top part of the trunnion is machined for receiving and keying to the gate arms.

The gate ring assembly consists of a cast-steel gate ring, cast-steel gate arms, and forged links and pins. The entire assembly is adjustable so that equal pressure will be exerted on each individual wicket gate. The bottom and the inner part of the gate ring are machined for mounting bronze bearing pads. The links and arms are fitted with bronze shearing pins designed to break if a gate should become blocked while moving in either direction. The arrangement is such that a broken pin will not interfere with the operation of the remainder of the gates. The gate ring is connected directly to the two wicket gate servomotors through piston rods and pins. The servomotors are mounted on bases provided in the lower pit liner and are fitted with outboard bearings for supporting the piston rod. The servomotors are equipped with locking devices for holding the gates in either the open or closed position against the maximum governor oil pressure of 300 lb. The arrangement is such that approximately equal pressure is exerted on the gate ring by each of the servomotors.

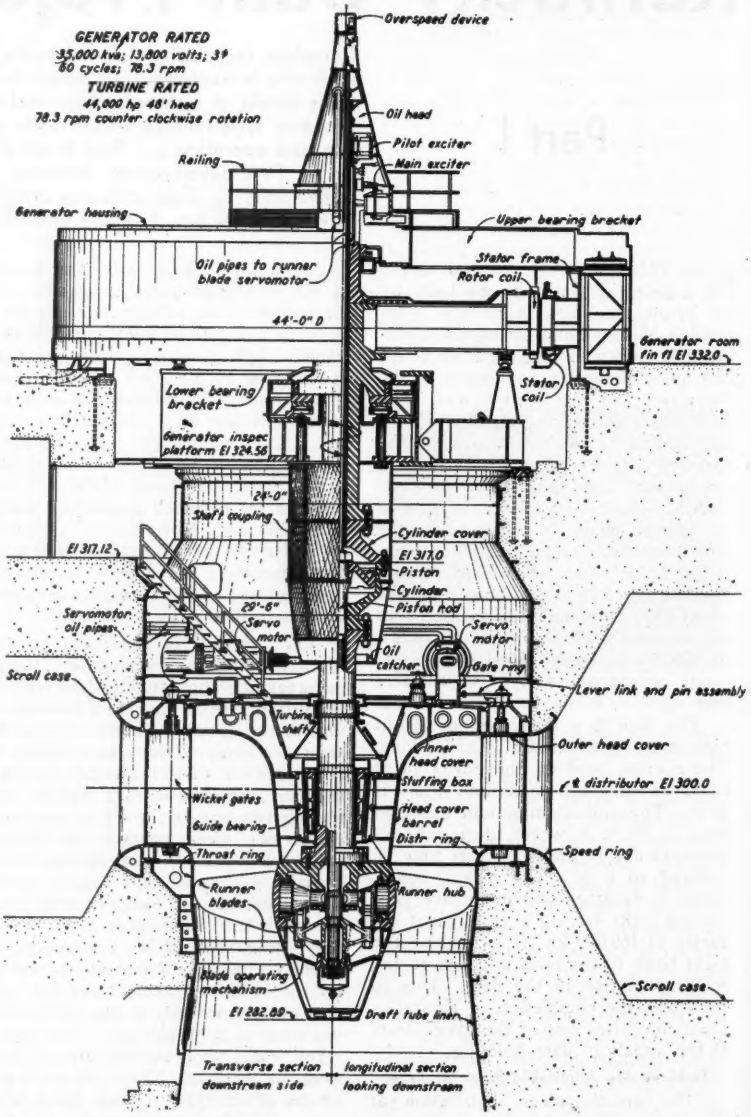


Fig. 2. Detailed cross-section of one of the Kentucky Dam 44,000-hp Kaplan (adjustable propeller type) hydraulic turbines and its 35,000 kva generator

Guide Bearing

The turbine guide bearing is water-lubricated, and the bearing housing is supported in the head cover barrel. The bearing consists of a set of six cast-iron shoes designed for mounting in a cast-iron housing. Each shoe is fitted with strips of "Insurok" bearing material. The height of the bearing is 66 in., and the surface is machined to the same diameter as the bearing sleeve. Lubricating water is supplied from the station water supply system through a 4-in. line. The supply line is equipped with flow indicators having two electric contacts, one for annunciation should the flow decrease to a predetermined minimum and the other to shut the turbine down upon loss of water.

Turbine Runner

The internal rotating parts of the turbine consist of the runner and shaft. The runner is composed of an integral steel hub casting which contains the blade-operating mechanism and six cast-steel runner blades. The blades are spherically turned to an outside diameter of 21 ft 7⅝ in. The bottom face of the runner blades is pre-welded with stainless steel in areas where experience has shown that cavitation is most likely to occur. The runner hub is fitted with an extension to guide the water as it leaves the wheel. The upper portions of the hub are machined and finished for bolting to the shaft. The blade-operating mechanism inside the hub consists of the piston rod, the cross head, and the connecting links and levers, all of which operate in oil. The runner center line is set at elevation 291.90 which is approximately 15 ft below normal tailwater.

Shaft Details

The turbine shaft has an over-all length of 17 ft 7 in. and a nominal outside diameter of 34 in. It is hollow-bored to a diameter of 16 in. for inspection and for containing the blade-operating servomotor piston rod. The shaft is made from an open-hearth carbon steel forging and is machined all over. It is fitted with stainless steel sleeves where it passes through the stuffing box and guide bearing. The shaft is flanged at each end for bolting to the runner hub on the bottom and to the servomotor cylinder on top.

The cylinder section of the shaft is a steel casting 4 ft 11¾ in. long, having a bottom flange 60 in. and a top flange 89 in. outside diameters. The piston is 67 in. in diameter and has a stroke of 8⅛ in. The piston is attached to the piston rod with a bolted connection. The inner oil pipe is attached to the top part of the piston for admitting governor oil under pressure to the under side of the piston.

The generator shaft connects to the top part of the servomotor cylinder and forms the cylinder cover. The generator shaft is hollow-bored to a diameter of 9½ in. for containing the inner and outer oil pipes and is machined for receiving the pipe cap into which the outer pipe is connected. Both the inner and outer pipes have pipe threads for screwed connections. The pipes extend through the entire length of the generator shaft, the exciters, and into the oil distributor head which is mounted on the pilot exciter.

The oil distributor head consists essentially of an integral steel casting with two separate chambers for directing the flow of oil under pressure from the governor oil pipes to the revolving oil pipes in the generator shaft leading to the blade servomotor. The oil head contains the bushing and packing glands for the revolving oil pipes. It is also equipped with an oil overflow alarm and air and oil bleeder valves. An indicator is provided on the face of the casting to show the position of the runner blades. The inner pipe is fitted with a rocker arm arrangement which, through relays, indicates the blade position on the face of the governor board and also serves as part of the Kaplan valve restoring mechanism. The top of the casting is machined and finished for mounting the overspeed switches and the tachometer drive.

All parts of the turbine which have relative motion in contact are fitted with alemite grease fittings for lubrication. A special barrel grease compressor is provided which will deliver a measured quantity of lubricant under 4000 psi pressure.

Governors

The governing equipment consists of four cabinet actuator-type governors, each having a minimum capacity at 250-psi governor pressure of 43,750 foot pounds per second.

The governors for the four turbines are contained in one single and two twin cabinets which are located on the generator floor. The cabinets enclose the governing mechanism and the oil pumps and motors, all of which are mounted upon a base formed by the governor oil sump tank. Each governor is equipped with a high-pressure storage tank and the necessary connecting piping. The single cabinet contains all the governing mechanism for one turbine and is equipped with two oil pumps and motors. Each twin cabinet is designed to contain the governing mechanism for two turbines and is equipped with two oil pumps and motors. The governor arrangement for each turbine is such that its pressure tank can be filled by either of the two oil pumps, and the arrangement of the twin governors is such that either or both turbines may be operated from either pressure tank. The pressure tanks are connected to the governors and the turbine servomotors by high-pressure piping with Van Stone flanges and long-radius bends and fittings of sufficient size to limit the velocity of the oil to less than 18 feet per second.

Runner Blade Control

The governor cabinets contain the valves and mechanism for operating the runner blade servomotors. Permanently attached cams of different shapes for different heads are provided so that, by using any given cam, the best runner blade, wicket gate relation is automat-

(*Continued on page 88*)

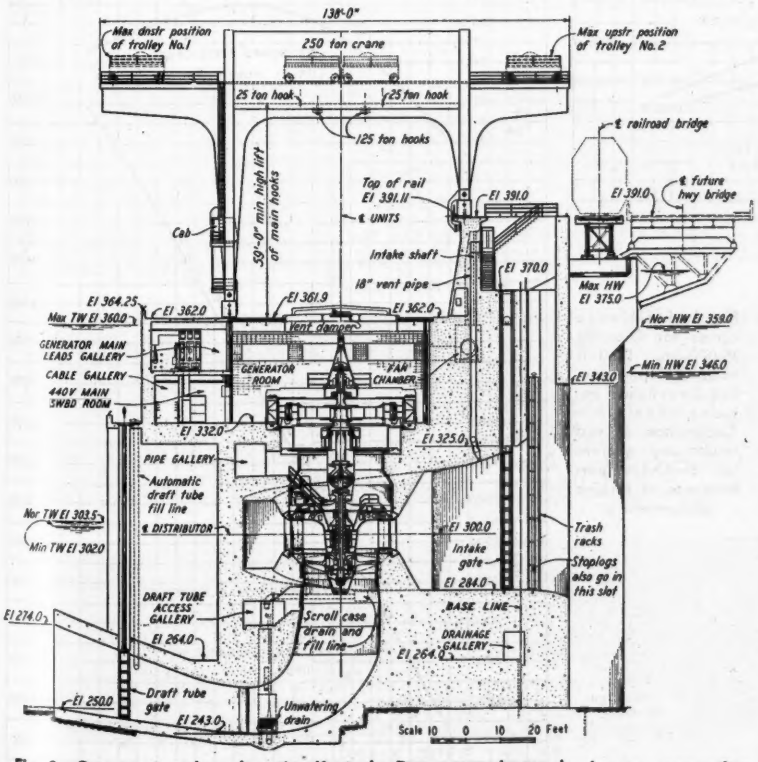


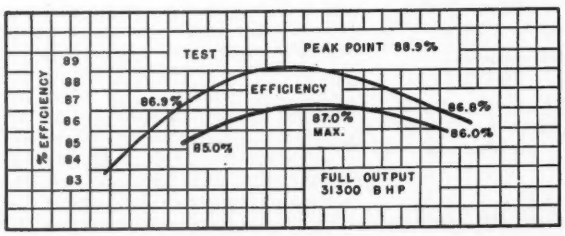
Fig. 3. **Cross-section through entire Kentucky Dam power house showing one generating unit and location of principal auxiliaries**

High Efficiencies Characterize Wartime Hydro Installations

Details of four outstanding examples . . . Glenville impulse wheel performance good while furnishing system speed regulation . . . Shipshaw unit holds world's record with 94.5 per cent turbine efficiency . . . Shasta 100,000-hp units at Grand Coulee show peak efficiency near 93 per cent . . . Santee Cooper adjustable-blade propeller type units have very flat efficiency curve

By C. R. MARTIN,
Hydraulic Dept.,
Allis-Chalmers Mfg. Co.

IMMEDIATELY PRECEDING and during the war period, the United States has developed some of its greatest water power plants. The total power developed during these years with hydraulic turbines on the American continent would reach approximately 10,000,000-hp. Among those can be cited the 1,000,000-hp plant at Boulder Canyon; the 1,200,000-hp plant at Shipshaw at the Aluminum Laboratories (designed in the United States but built and installed in Canada); the 1,300,000-hp initial development at Grand Coulee (3,200,000-hp when completed); the 700,000-hp development at Bonneville; the initial 200,000-hp at Shasta (500,000-hp when completed) and many other plants which would have been considered large in former years. These plants have necessitated a large concentration of engineering talent in their construction that have brought turbine efficiencies to higher levels than ever obtained in former years. The four examples of these recent plants show commendable results and in one case a world's record for high efficiency.



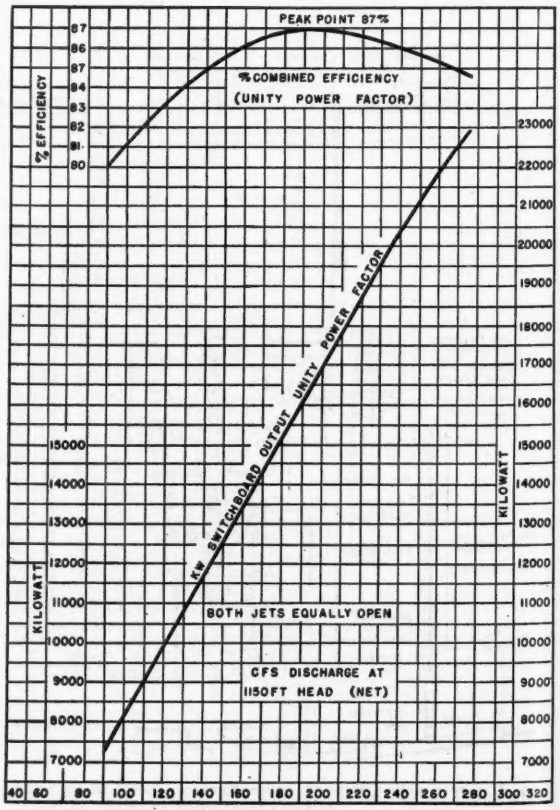


Fig. 1. Efficiency curves for Glenville 30,000-hp, 1150-ft head, 257-rpm, double-overhung impulse wheel. A—Comparison of test results and guarantee. B—Overall performance of turbine and generator

Glenville Plant

The first plant that deserves mention is the Glenville plant[1] installed by the Nantahala Power Co. at Glenville, North Carolina. This was a 30,000-hp double-overhung impulse wheel operating under 1150 ft head at 257 rpm. The efficiency guaranteed and the efficiency obtained are shown in Fig. 1. While the efficiency of this plant is probably not the highest peak ever obtained on an impulse wheel, it does represent a very high efficiency obtained with such a large jet.

Higher efficiencies on impulse wheels have been obtained in laboratory tests on medium size equipment under relatively low heads, but with the mechanical difficulties to be overcome in design in the larger size and higher head impulse wheels, the results obtained at Glenville represent a very creditable manufacturing achievement.

One of the principal operating functions of the Glenville installation is to furnish speed regulation on the system. The unit was designed to accomplish this by using a deflecting nozzle for quickly reducing the horsepower input to the turbine during times of load rejection, followed by a slow reduction in the jet to restore efficient operation. Figure 2 shows the regulation obtained at this plant.

The unit installed at the Glenville plant has the distinction of being the only large capacity impulse turbine east of the Rocky Mountains. It is a horizontal shaft, single-jet, double-overhung wheel with shaft supported in two bearings and the generator located between them. One shaft end is extended for coupling to the exciter, the pilot exciter and the independent generator supplying current to the motor driving the flyballs of the governor.

Being of the double-overhung type, the two water wheels, one on each shaft end, constitute two independent hydraulic prime movers, each with its own governor and gate valve, so that the water on one side can be shut off entirely without interfering with the other. When small outputs of less than 50 percent are necessary or desirable, a better wheel efficiency can also be maintained. Also, individual control of each water

Numbered references at end of article.

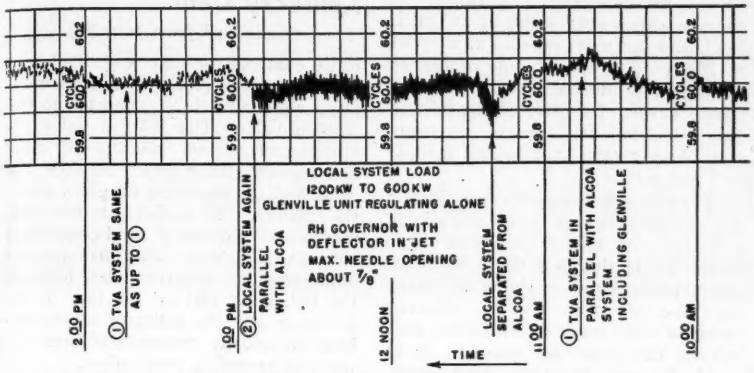

60.2
CYCLES
60.0
59.8
2 00 PM
① TVA SYSTEM SAME AS UP TO ①
1 09 PM
② LOCAL SYSTEM AGAIN PARALLEL WITH ALCOA
LOCAL SYSTEM LOAD 1200 KW TO 600 KW GLENVILLE UNIT REGULATING ALONE
RH GOVERNOR WITH DEFLECTOR IN JET MAX. NEEDLE OPENING ABOUT 7/8"
12 NOON
LOCAL SYSTEM SEPARATED FROM ALCOA
11 09 AM
① TVA SYSTEM IN PARALLEL WITH ALCOA SYSTEM INCLUDING GLENVILLE
10 00 AM
TIME

Fig. 2. Chart showing typical performance of Glenville 30,000-hp double-overhung impulse unit while regulating system frequency

wheel by its own governor assures a double safety, maintaining control over half the output of the unit if the governor of the other half fails to operate properly.

To avoid dangerous rises and surges in the pressure tunnel several miles long, with no surge tank, the change of water velocity under fluctuating load must be very gradual. To obtain quick response of the unit to load changes the output must be changed quickly by a corresponding change of water quantity impinging on the buckets. In many cases it has been the practice in the past to move the needle of the jet rapidly and open a relief valve in synchronism, to discharge the amount shut-off by the needle, and then thereafter close the relief outlet at a rate to prevent secondary pressure rises in the pipelines. Thus by keeping the sum of the two discharges equal, the velocity of the water in the pipeline is kept constant.

In the Glenville unit, however, another method is employed, first used on the 60,000-hp impulse wheel at Big Creek 2-A plant. This is to provide a means for quickly diverting the jet from the buckets and to let the flow controlling needle follow the movement at a rate independent of the rate of deflection but in accordance with the pipeline requirements.

This is accomplished by the jet deflectors between nozzle orifice and rotating buckets. The deflector surrounds the jet without interference when in neutral position to assure highest output efficiency. The portion surrounding the jet is lined with a removable steel sleeve. The deflector is hinged and extended at the lower end for pivoted connections into the nozzle pipe pit where it is coupled to its oil pressure servomotor. To facilitate frequent examination, the supports for the hinges of the deflector can be readily moved out of the way for quick access to the orifice. A stilling pool with splitters is installed to receive the deflected jet and dissipate its high energy, thus preventing destructive effects in the tailrace.

Shasta Units at Grand Coulee

Two of the 100,000-hp units originally built for Shasta Dam[2] were installed at Grand Coulee.[3] These units were placed in operation in 1943. An efficiency curve of one of these units as tested by the Gibson method[4] under a head of 350 ft, as in Fig. 3B, shows that the peak efficiency reaches almost 93 per cent. Each of these units was changed to fit the Grand Coulee installation and the intake to the casing and the outlet from the draft tube were materially altered to suit the existing concrete. This, of course, reduced the efficiency which could otherwise have been obtained. It will be interesting to see the efficiency of the Shasta units when they are tested, with the turbines installed correctly in the setting for which they were designed.

Shipshaw No. 9 Holds World's Record

The wartime installation which probably has created the most interest is the Canadian Shipshaw development[5] of the Aluminum Laboratories, Ltd. This plant was installed on the Saguenay River which discharges into the St. Lawrence River about 120 miles downstream from Quebec. These turbines were all designed in the United States by U. S. engineers. Each of the turbines develops approximately 100,000-hp under 208 ft head and operates at a speed of 128½ rpm. Much has been written about the details of this plant, particularly with reference to the speed with which over 1,200,000-hp (in twelve units) was added to our war effort.

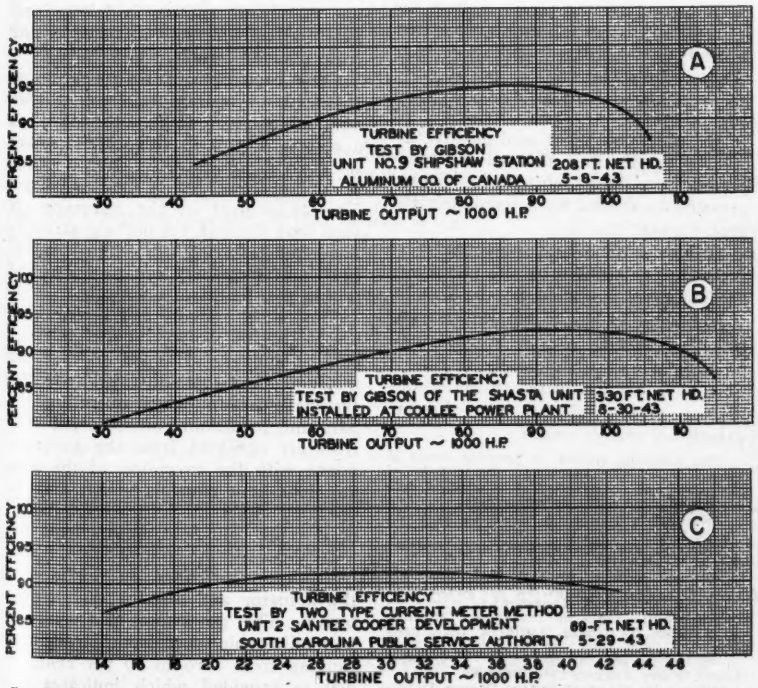

A
PERCENT EFFICIENCY
TURBINE EFFICIENCY
TEST BY GIBSON
UNIT NO. 9 SHIPSHAW STATION 208 FT. NET HD.
ALUMINUM CO. OF CANADA 5-8-43
TURBINE OUTPUT ~ 1000 H.P.
B
PERCENT EFFICIENCY
TURBINE EFFICIENCY
TEST BY GIBSON OF THE SHASTA UNIT 330 FT. NET HD.
INSTALLED AT COULEE POWER PLANT 8-30-43
TURBINE OUTPUT ~ 1000 H.P.
C
PERCENT EFFICIENCY
TURBINE EFFICIENCY
TEST BY TWO TYPE CURRENT METER METHOD
UNIT 2 SANTEE COOPER DEVELOPMENT 69-FT. NET HD.
SOUTH CAROLINA PUBLIC SERVICE AUTHORITY 5-29-43
TURBINE OUTPUT ~ 1000 H.P.

Fig. 3. Curves of turbine efficiency for three of the wartime hydraulic turbine units. A—Unit No. 9; Shipshaw. B—Shasta unit installed at Grand Coulee. C—Santee Cooper unit

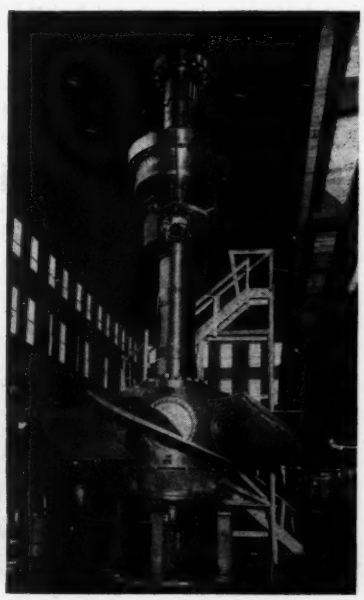


Fig. 4. Shop view of Santee-Cooper runner and shaft assembly

Fig. 5. Piping for supplying grease lubrication to guide vane pivots, Santee-Cooper unit

The runners used for these turbines were ideal hydraulically for high efficiencies in that the minimum sum of hydraulic and mechanical losses occur with this type of runner.

Only the Boulder Dam plant, which took 7 years to complete, approaches the size of the huge Shipshaw station. The Shipshaw plant was started in 1941 and the last unit was placed in operation in November, 1943, a period of approximately 2½ years.

The world's record for hydraulic turbine efficiency—94.5 per cent—is shown in Fig. 3A. The Gibson method of test was used at the Shipshaw plant on unit No. 9, tested in May, 1943, soon after the unit was placed in operation. Of this 5½ per cent short of perfection, approximately one-half is in the draft tube and would be impossible to regain economically, so that only about 2¾ per cent is actually lost in the machine itself. These losses would include friction, leakage and hydraulic losses in the runner.

Santee-Cooper Units

To complete this representative survey, the Santee-Cooper plant,[6] which is a comparatively low head installation, should be included. The rating on these machines was 40,000-hp at 70 ft head, and the units operate at a speed of 120 rpm. A special type of runner was used, producing a very flat efficiency curve. Its peak efficiency was only 91.4, but its average efficiency from 40 per cent load to full load is 90.9 per cent.

These operating results fully justify the decision to use a comparatively new type of turbine for such high heads, for in this case the prime consideration was the obtaining of a very flat type of curve. A flat efficiency allows a wide range in operation, permitting this plant, for example, to fit in ideally with its steam counterpart. It is an outstanding example of how hydraulic and steam can be made to operate together for maximum efficiency of both types.

Fig. 4, a shop view, shows the general design of the Kaplan adjustable blade type turbine runner installed at the Pinopolis plant of the Santee-Cooper project. Two of the interesting features of this unit are shown in Fig. 5 and 6.

One of these features is a motor-driven pump, Fig. 6, designed to maintain constant oil pressure in the hub of the turbine runner. This pump is operated from a pressure control connected to the runner hub. If the pressure decreases in the runner hub, oil is drawn from a special oil container mounted on the shaft and pumped to the hub to maintain the pressure constant. The slip rings supplying power to the pump motor are shown in Fig. 6, also the pump just below the motor, the control switch on the right and the pressure control valve on the left.

A second feature of the unit is the lubricating system for supplying grease to each of the pivots in the guide vane operating mechanism. A special valve prevents grease from going to the next adjacent pivot until it has been supplied to the preceding pivot, and positive indication is obtained that all the pivot points have been lubricated. Grease pressure is applied by a hand-operated grease gun.

While outstanding efficiency records are represented by the plants described here, it should not be implied that higher hydraulic efficiencies cannot be obtained. This is something to be striven for; undoubtedly improved designs will be reflected in better operating results of our after-the-war plants.

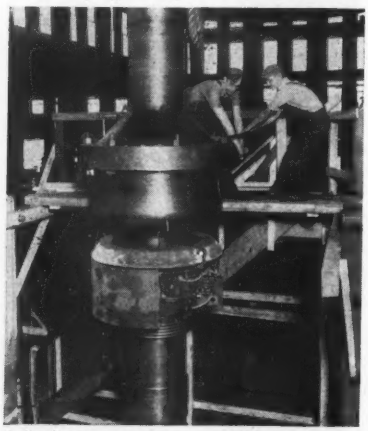


Fig. 6. Motor-driven pump and controls for maintaining constant runner hub oil pressure, Santee-Cooper unit

The following articles, in previous issues of POWER PLANT ENGINEERING, give details of equipment and construction of interest in connection with the above operating data:

[1]Nantahala Power Co. Glenville to Build Hydro Plants; June, 1940, page 96.

[2]Shasta, Key to Central Valley; September, 1944, page 78.

[3]Grand Coulee; January, 1942, page 68; February, 1942, pages 54, 69, 84; April, 1942, page 142; August, 1942, page 81.

[4]Hydraulic Tests by the Gibson Method, by Norman H. Gibson, April 15, 1927, page 469.

[5]Shipshaw on the Saguenay to Develop 1,500,000 hp; August, 1943, page 86.

[6]Pinopolis Plant of Santee Cooper Development; September, 1942, page 78; April, 1943, page 166.

Kentucky Dam

(*Continued from page* 85)

ically obtained for that head. Different cams are placed into operation by moving a roller, which is connected to the Kaplan valve. The Kaplan valve restoring mechanism consists of cable and sheave arrangement between the valve and the revolving oil pipes above the exciters. The wicket gate restoring mechanism consists of rigid connecting rods and brackets. This arrangement eliminates the discrepancies between the indicating dial on the face of the governor and the indicator in the turbine pit usually encountered with cable-type restoring mechanism.

The normal operating pressure of the governor systems is 300 psi. The initial pressure in the pressure tanks is built up by means of an air compressor designed to deliver 13 cfm against 300 pounds. This pressure is then maintained by the governor oil pumps, which are set to operate between a maximum of 300 psi and a minimum of 270 psi. The connections to the oil pumps are arranged so that normally only one pump is used; however, if the pressure in the system drops below 270 psi, the second pump automatically comes into operation.

The speed responsive element of each governing mechanism consists of a set of flyballs driven by a direct-connected alternating-current motor, assembled as a unit and connected to the other governing mechanism in the cabinet. The speed of the flyballs varies in direct proportion to the speed of the turbine and is not affected by the ordinary variations in voltage or current of the main generator or its exciters. The source of power for driving the flyball motors is taken from potential transformers attached to the main generator leads.

The capacity of the governors is sufficient to operate the wicket gate and runner blade servomotors through a complete cycle in either the opening or closing direction in four seconds under any condition of load and head. The adjustment of the governors is such that through the porting arrangement and restoring ratios the "off-the-line" unit frequency can be controlled within two-tenths of one cycle.

The unit controls and instruments are located on the face of the governor cabinet and are arranged so that the instruments are plainly visible to the turbine operator when operating the gate and load-limit controls. All controls are operated from the governor board with the exception of the gate and load-limit controls which may be operated either at the governor board or through split field motors from the switchboard in the control room. Speed indication is provided on the face of the actuator and also at the switchboard. The governors are equipped with adjustable speed droop mechanism ranging from zero to 10 per cent. A dial is provided which indicates the amount of droop employed.

The
PRACTICAL ENGINEER and ELECTRICIAN
ANDREW W. KRAMER, EDITOR

MORE DAMN FUN

"More damn fun" is how The New Yorker summed up a cocktail party given by the General Electric Co. at the Engineers' Club in New York recently at which G-E introduced a new synthetic rubber called Silicone. Silicones—curious compounds of silicon—had been previously announced as resins, oils, insulations, and water-repellents. Startling new silicones have now been evolved in the Research Laboratory—silicone rubbers which retain their elastic properties at temperatures from —60 to 575 F.

One curious form of silicone rubber is "bouncing putty." It can be kneaded and pulled like putty, but when rolled into a ball it bounces like rubber. This is where the fun at the cocktail party came in. Along with Scotch-and-soda, everybody at the party received a sample of the bouncing putty and according to the reporter for The New Yorker, this combination made for some frivolous goings on. Some representatives of the press pulled their samples into long gooey strings, others rolled them into balls and bounced them. A couple of morosely sportative photographers draped a G-E chemist with strands of the bouncing putty which made him gigglingly nervous. Before order was finally called, some of the guests were trying to stuff the putty into one another's ears. The material is both elastic and plastic and which of these properties it exhibits depends on the rate at which stress is applied. Struck sharply it is rubbery; squeezed slowly, it is putty-like. Anyway the party was lots of fun. Before it was over, "fired by Scotch and visions of the post-war world," the photographers draped the chandelier with strands of the putty. One chemist admitted it was his first press party, "They said it would do me good to get out of the laboratory for a while, but," he sighed, "I sort of wish I were back in Schenectady."

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Twenty Years at Ponoka

Part II. This is a continuation of an account started in the November issue, describing the rehabilitation of the power plant at the Ponoka Provincial Mental Hospital in Alberta, Canada, over a period of twenty years. In this final installment, Mr. White completes his description of the general conditions and then proceeds to a discussion of the intermediate and final stages involving further growing pains and ultimate results

By WILLIAM S. WHITE

Chief Engineer, Provincial Mental Hospital
Ponoka, Alberta, Canada

AS WAS EXPLAINED in the first part of this article in the November issue, in an offset of the engine room toward the brick chimney, a walled-in basement had been sunk, and in this, some genius had installed three wet vacuum pumps to take care of the heating system.

These units were connected up in such a manner, with the water end so close to the return header on one wall of the basement, that a mechanic had to be a contortionist to repack the liquid pistons.

With so little space provided, and the general hole and corner arrangement, it was evident that as little repair work as possible had been done on these vacuum pumps. The returns from the heating system were so hot, that continuous injection of cold raw water was necessary to maintain a slight vacuum. To reduce the wastage to overflow, and conserve the condensate for boiler feed, a substitute injection was rigged up whereby part of the discharge from the pumps was recirculated through a cooling coil, back to the suction side. This worked very well, until the heating system became the responsibility of the chief engineer, when eventually the necessity of injection water was done away with altogether.

These pumps discharged against a 30 ft head into the small 200 hp open exhaust heater already referred to, and at times a great deal of condensate was wasted, through the heater overflow. As a means of conserving this waste and through force of circumstances the arrangement finally arrived at consisted of a home made control which closed the discharge line into the heater and passed the discharge from the pumps into a storage tank higher up above the heater. The regular float control incorporated in the exhaust heater was set not to allow any water from the storage tank to enter the heater until the water level in glass of the water heater had fallen to 3 in. above the bottom nut. The height above this 3-in. level and the overflow line of the heater operated the home made control which consisted of a 2½ in. pipe post bolted vertically to one of the steel beams on which the heater body was supported. A slot in the upper end of the post allowed a lever of ⅝ in. by 2½ in. by 6 ft flat iron, to turn on a knife edge set in a hole drilled through the post. On one end of this lever, a drum was suspended, which held about 7 gal of water when full, and this drum was connected from its bottom, to the bottom of the heater, by sufficient ¾ in. flexible rubber hose, to allow it to move freely. Similarly, the top of the drum was connected to the top side of the heater. The drum was counterbalanced at the other end of the lever, by a suspended bucket weighted with scrap pieces of iron.

As the water in the heater rose to the overflow point it also rose in the suspended drum causing it to overcome the counterbalance and the movement of the lever through a reach rod, closed a regular float valve set in the waterline direct into the heater. Thus, the discharge from the vacuum pumps was forced up another line into the storage tank until the water level had fallen sufficiently in the heater. When the counter weight reversed the motion of the lever resulting from the water receding from the drum the discharge from the pumps would pass into the heater. It is recognized that this arrangement as described, is at best only a compromise over pumping all the discharge direct to the storage tank, but in actual operation it proved much more satisfactory. From an engineering point of view, it would be much better to have the vacuum pumps discharge into a hotwell and have a float controlled pump discharge from the hotwell to the storage tank. Here again, the operating engineer is not designing plants, but has to make the best of circumstances as he finds them.

In time, owing to the expansion of the hospital facilities, it was conceded, that a larger vacuum pump would be required, so one of the 15,000 sq ft E.D.R. vacuum pumps was removed from the basement, and an 80,000 sq ft wet vacuum pump installed in its place but if the chief engineer had any visions of remodelling the vacuum pit at the time, he has forgotten all about them, recognizing as he does that power plants of insane asylums are different. This statement may seem a little far fetched, but the same old conditions still exist in the vacuum pump basement and this is now partially covered by a floor put in to find a place for two motor generator sets using d-c current to produce a-c.

The Refrigerating Plant

In the refrigerating section of the power plant, there are two 15 ton vertical York ammonia compressors, one directly connected, steam driven, the other electrically driven, belt connected. The system is partly brine circulation and partly direct expansion. The room in which the compressors and associated equipment are installed is on the basement level of the engine room and was entirely separated from the engine room by a blank wall. The engineer had either to go outside the engine room and around one side of it to enter the outside door and down steps into the compressor room or go into the boiler room, walk along the space between the back of the settings and the engine room wall and enter through a door which led over the brine tank and down steps onto the floor of this basement. If one entered by the outside door and down the steps he had to pass through a narrow space between the d-c motor driving one compressor and a wall or pass along a narrow space between the belt and the steps and around the compressor. It was evident at the time, that if anything happened that called for a hurried exit from the compressor room, either way slowed down rapid escape.

The simplest and easiest way that presented itself of making conditions

It was pointed out in the first installment of this article in the November issue, that this is a story that should make any conscientious engineer sad, and weary. A reading of this second part has not changed our opinion in the slightest degree. We wonder how it is that Mr. White managed to keep from becoming a patient in the hospital through all these years. By all rules he should have gone "nuts" long ago. If they were not tragic, some of the things Mr. White describes would be funny—the way they restricted the size of the new engine to fit the available space in the engine room for example. It makes an interesting narrative but we still wonder why conditions such as described here should have to exist in any power plant. If Mr. White's case was an isolated instance it would merely be funny but unfortunately conditions such as were found at the Ponoka Hospital prevail in many other small and medium sized power plants throughout the country. As in this case, it is usually the fault of management, which refuses to heed the advice or recommendations of the engineer in charge

sater was to move the motor close up to the compressor and use a belt tightener which was done as fast as circumstances would allow. This provided ample space to the concrete steps leading up to the outside door. Eventually, owing to the growth of the hospital and changes that had to be made in the engine room and the removal of a switchboard from the intervening wall between the engine and compressor room, a doorway was provided in this wall which allowed much shorter access to the refrigerating machinery. Although there was a reasonable amount of floor space the steam-driven ammonia compressor had been installed as close up to the brine tank as it was possible to get it. It was operated for a good many years in this position before an opportunity offered which allowed the brine tank to be moved over to give some space between the machine and the tank.

The direct expansion part of the refrigerating system which is carried into rooms in part of the hospital proper is installed upside down to the generally accepted methods and undoubtedly is wasteful in the power required. No opportunity has ever arisen to have much done to this, and it is still functioning more or less in the original state. Two sets of condensing coils had been provided, one for each compressor but not interconnected, except into the single liquid receiver. As soon as it could be accomplished, a cross-over connection was fitted into the compressor gas lines so that either coil could be used, or both, irrespective of which compressor was operating.

In maintaining the cooling effect of the water circulating tubes in these coils, it was found that they tended to accumulate quite a deposit which tended to harden or set, in comparatively short periods. As there was a supply of compressed air, provided by a second hand Westinghouse air pump picked up in some railroad yard, an air agitator was rigged up and connected to the entrance water pipe of the coils and by using this periodically it was found that this kept the cooling surface in efficient shape. Using the air agitator, and watching the discharge from the open end drain of the coils showed good results in the color of the water and the solids carried out with it.

A New Expansion Program Brings Trouble

With the ever present necessity in hospitals of this kind of more accommodation for patients, plans for new buildings had caused a decision to be reached in favor of a new power plant to be built on modern lines. As a consequence instructions were issued that no further reformations or changes would be allowed in the old plant and only necessary repairs were to be carried out. This state of affairs did not help much when after two years or so a building program was suddenly launched and the old power plant with some additions was called upon to meet the increased load.

All this will have a familiar ring to a good many engineers. What was needed actually, as the need for the power plant and the service systems to be extended from it increased, seemed to be lost in the haze of expense surrounding the new additions. As I am dealing with the power plant itself, the difficulties arising out of getting some consideration for carrying the services required to the scattered new buildings in the way of underground tunnels, piping, basement accommodation, etc., will not be dealt with, as it would be too long a story.

It became evident to the authorities over the chief engineer that what was considered necessary for the power plant, were coal bunkers with weighing apparatus, and the necessary elevator and ash storage tank with elevator. The actual increase in capacity was confined to a large power unit in the engine room. The coal handling, and probably the ash handling equipment, was provided primarily as a means of reducing the dust that settled in nearby wards, when the windows were opened. It is doubtful otherwise that such equipment would have been considered. Economically it provided no advantage over previous methods and the cost could have been used to advantage on the plant elsewhere. The coal bunkers proved a great convenience but the ash handling apparatus solved nothing, as the ashes had still to be taken out of the ashpits sunk in the floor under the furnaces by hand and wheeled in barrows to the elevator. Overhead coal bunkers and a convenient and methodical method of weighing the coal had been introduced, before pressure was brought to bear for a more methodical way of burning it than by handfiring.

In the end, two low priced stokers were provided for two of the boilers, and steam meters of the steam flow, air flow type installed on all of the four boilers. The 200 kw d-c Belliss and Morcom engine and generator provided was one-third less in capacity than should have been the case. This had to be installed in the only vacant space in the engine room which had too little ceiling in any case. It looked as if the engine size had been restricted to suit the conditions.

The Boilers Fail

It so happened that a year after these additions had been made, that a serious condition was found on one of the boiler drum girth seams where both sheets had cracked between and around the rivet holes, below the water level, and extending around and above on either side. This discovery came soon after the annual inspection when every part had appeared all right. The investigation that resulted pointed to caustic embrittlement and when the other boiler drums were examined by the removal of rivets below

"I was told last week to inspect the boiler over here right away. Where is it?"

the waterline two more of the drums were found cracked at the rivet joints. Strange to say in the remaining boiler drum of the four not one sign of caustic embrittlement could be discovered after a thorough examination. As the condition of the boilers was disclosed in the fall, the winter load had to be, and was, carried by one boiler at the usual working pressure together with two other boilers allowed to carry 40 lb W.P., in which the heads had been reinforced by welding. The fourth boiler was totally out of commission. The saving feature was that the boiler allowed to carry full W.P. had one of the stokers installed under it which had taken much argument to get, and for nearly two years this boiler was seldom below 200 per cent rating, with peaks recorded at 240 per cent. It was finally taken off the line when the other boiler with the stoker under it equipped with a new drum and tubes was put into service.

Eventually, all boilers were equipped with new drums and two of the boilers, with new tubes. The condition of affairs that existed for over three years in the cramped space of an unsuitable boiler room before order was restored must be left to the imagination.

The performance of the stoker-fired boiler during the worst period of boiler trouble induced the authorities to provide cheap stokers of another type for the other two boilers and these were installed when the dismantled settings were rebuilt after the boiler repairs caused by embrittlement had been made.

The alarm over the failure of the drums resolved itself into instructions and directions by some outside authority that the sodium sulphate carbonate ratio of 2 to 1 was to be maintained in the boilers by the addition of sufficient Glaubers salts and samples of the boiler water were to be submitted weekly for checking. In trying to hold the ratio as advised the density of the boiler water became too high, with resultant carryover, and the blowdown was out of all proportion. The remedy proved worse than the disease. As usual, the chief engineer had to produce something out of the hat or take the consequence if anything should happen. After some quiet experiments with sulphuric acid it was found that the density of the boiler water could be much more easily controlled if the acid was substituted for the salts but the matter of feeding the acid consistently in the right amount to the raw makeup feedwater, which varied largely according to the period of the year, was not so easily solved.

The apparatus finally evolved for acid feeding, was made of a 30 in. diameter by 54 in. circular tank into which the water for makeup flowed through a tank float valve and down into the tank through a pipe leg carried near to the bottom. A float controlled outlet was arranged similarly, to work inversely, so that when one valve was open the other was shut. To provide positive opening and closing of the valves in operation, both float valve levers were connected at either ends by distance pieces. A single rectangular float was provided to which were attached two vertical rods some distance apart that travelled through eyes in one of the distance pieces and were made long enough to be steadied above by a set of guides. With light wire coil springs on the float rods, on either side of the eyes in the distance piece, sufficient tension was developed to spring the latches fitted on the lever guides of the float valves, to snap the valves open and shut, when the tank was nearly full or empty. On the top of the incoming down leg leading down into the tank, a packing gland and nut was fitted into the tee, which carried a ½ in. by 14 in. water glass, the larger portion of which projected down inside the leg beyond the tee. Into the outside portion of the glass, a ¼ in. lead pipe was fitted and sealed and the pipe carried over to, and down, into a glass jar containing sulphuric acid. The end of the pipe in the acid was closed except for a small hole arrived at by trial and error. A small balanced elevator platform carried the acid jar, which makes for easy filling, and allows adjustment for the exact head to be carried against the syphoning action of the inrushing water down the pipe leg. By testing samples taken from the tank, the amount of acid needed can be set very closely. The protective effort made against further caustic embrittlement, brought about a reasonable attitude to the request which had been held up for some time, for chemical apparatus to test the boiler water. After some experimentation, it was established that the density of the dissolved solids carried in the boilers had been carried too high and to prevent any carryover in the steam much lower densities were required. This was ascertained by analyzing numerous samples of condensate gathered from various points. In our case 150 grains per U. S. gallon apparently was the limit at the rating the boilers generally operated. A very noticeable reduction in the quantity of cylinder oil used in the engines and general wear on moving parts resulted.

As already mentioned a new 200 kw d-c generator was to be installed in the limited space in the engine room and in conjunction with this, it was found necessary to replace the geared turbine unit with a second hand 125 kva engine unit. To provide enough space, two motor generator sets had to be moved onto a reinforced concrete floor that had to be made over the vacuum pump basement to accommodate them. This has been referred to in describing the vacuum pumps. In establishing foundations for these engines and generators a basement had to be dug out and floored with a heavy reinforced concrete mat on which the foundation concrete bases of the engines were set. All the work of installation had to be carried out while maintaining full operation of the plant.

A sequel to this cramped engine room layout was a sudden decision on the part of those in higher authority (than, should I say, the unfortunate chief?) about two years later to regroup the separate a-c and d-c switchboards and equipment into an extension built onto one of the exposed sides of the engine room. A full basement was made under this extension to take care of the cables and wires, balance coils, and some transformers. This change certainly improved the engine room but compared with the attitude taken previously on space requirements in the engine room and vacuum pump basement, it seemed an extraordinary thing to do.

Reducing Steam Consumption

A quantity often underestimated, is the amount of live steam at various reduced pressures used by the laundry, kitchens, sterilizers, and other apparatus. In this plant steam had been taken off at various points where most convenient to get a steam supply for the different pressure services. These branches were rearranged to take the steam from one outlet pipe in which the orifice of a recording meter was fitted. The meter itself was a relic of earlier days. Inasmuch as the orifice was calculated and made up at the plant there was always some doubt that amount of steam registered as being used in process work was as great as indicated. As a check one boiler was segregated so that it supplied steam to the process system alone. It was found that the process meter was registering 4.7 per cent less steam than the meter on the boiler and that the peak demand was, in the daytime, 5000 lb per hr.

Many heating appliances are used in hospitals and, as often is the case, these are electrical but if some consideration and thought had been given steam could have been used to better advantage and with greater economy. In our case, service lines with steam at 40 psi were provided to carry steam to all points where it could be used to better advantage than electrical heating apparatus. Coffee urns, warming cabinets for dishes, and warming tables for food are cases in point. Quite a number of kilowatts can be dropped from the load and the electrical repair bill reduced considerably. The change-over to steam instead of electricity for heating as far as was conveniently possible brought about a permanent drop of 35 kw from the electrical load at this hospital.

I believe enough has been touched on to give a good general idea of what the chief engineer is up against in an institution of this kind. With a better system of organization and a recognition of the fact that mental hospitals are an asset and not a liability, in which expense has to be kept at a minimum, the public at large would derive much greater benefit.

I think the best way to close this article and sum up the results obtained through the power plant is to simply state, that while 30 per cent more buildings were added to the hospital, no more coal or Btu's are being used than previously, that all utility services are much better and that there is sufficient reserve in the plant to take care of 30 per cent more buildings if necessary as far as the boiler room is concerned.

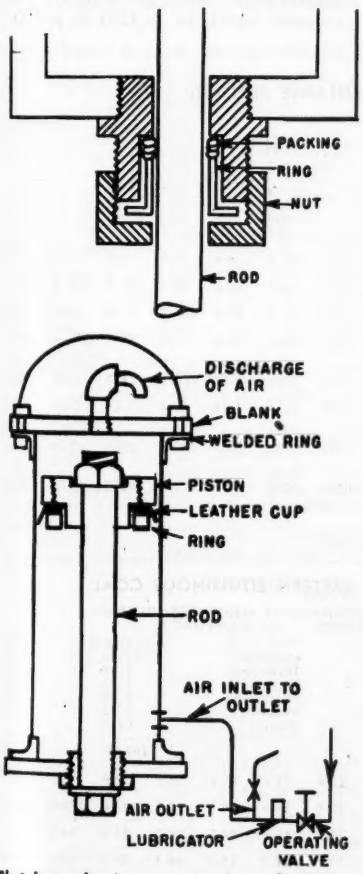
PRACTICAL HINTS AND KINKS

Making an Ash Hoist

By William Otto

WE HAVE HAD considerable trouble trying to hoist an ash bucket seven feet from ash pit on account of not being able to buy an electric, hydraulic or air hoist. We tried several makes of second hand winches but they did not work out satisfactorily, and required two men to operate.

I offered a reward of five dollars for the best suggestion, but still I got nowhere fast. The next best thing to do was to check the junk pile. I found a piece of 6 in. steel tubing 7 ft long, with an internal diameter of 6 in. and an outside diameter of 6½ in. We also found two 6-in. steel ring flanges and two steel blanks for heads. We welded the rings to the tubing and bolted the



Sketches, showing construction of air-operated ash hoist

blanks to the flange. We found a piece of round ground rod 1½-in. diameter, which was previously used for pump piston rods. For the piston we turned up a piece of 6-in. cold rolled steel and bolted this to the rod. On the bottom of the piston, 6 holes were drilled and tapped, and a blank flange was turned up 1 in. smaller than the piston which was drilled to fit holes in piston. Then we purchased a 6-in. leather cup and placed it between the blank and piston, bolted it together with the cup facing downward. In the bottom head which was a blank flange we drilled and tapped holes to an old stuffing box which was salvaged from an old steam pump. The stem of stuffing box was threaded to fit hole in flange. The end of piston rod was turned and threaded for a swivel hook. At the bottom of the steel tubing we drilled and tapped a hole for ½-in. pipe used as an inlet and outlet for air. On the top, a hole was also drilled and tapped for ½-in. pipe to discharge the air when piston comes up. Then a flexible connection was made from the top and bottom of the hoist with a ¾-in. air hose, to a solid pipe connection on a column to operate the hoist. Two valves were used, one to discharge the air, the other for inlet.

This hoist rests on two I beams above the pit and a trolley rail runs to the hoist. This hoist picks up 1000 lb at 85-lb air pressure without any effort and can be stopped in any position just by operating valves.

Useful Helps Around the Plant

By Thomas Trail

BEFORE USING new drills and taps, the rust-protecting coating of grease should be removed from them. If this is not done they will become clogged with metal shavings and chips, which will adhere to the grease and will impair their usefulness.

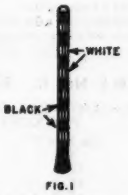


Fig. 1. Showing how drills can be painted with alternate black and white stripes

A small brush dipped in cleaning fluid such as tetrachloride or Stoddard's Fluid will effectively clean these tools.

Don't Throw Away Discarded Toothbrushes

Toothbrushes, when worn out, should not be discarded since they are very useful around the home or shop. They are ideal for cleaning small parts, for brushing out hard-to-reach corners, for brushing shellac or cement on gaskets, for brushing chips from taps and dies, etc.

Masonry Drills

When using masonry drills to drill holes overhead in light-colored walls or ceilings it is difficult to see the drill or hammer head because of the light-colored background. Consequently, the hammer may miss the drill and strike the user's

Fig. 2. Hammer with a white head

hand. To overcome this difficulty it is suggested that such drills be painted with alternate white and black stripes, as shown in Fig. 1. Also, it may be advisable to paint a white circle around the

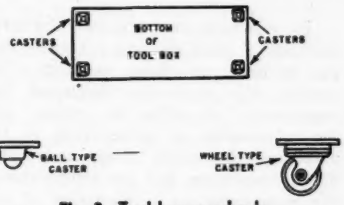


Fig. 3. Tool box on wheels

striking face of the hammer head, as shown in Fig. 2, to make it easier to see. The hammer head and the drills may be painted all black and then striped in white.

Tool Box on Wheels

Heavy tool boxes may be moved about more easily, especially while working around automobiles or machinery, if a set of casters be mounted on the bottom of the box, as shown in Fig. 3.

Repairing Old Check Valves

By Bro. John Jos. Geisen
St. Joseph's College, Westmont, Ill.

DURING the summer months while making the routine repairs to the equipment in our power plant, we opened the receiving tank into which the condensate from the heating system is discharged. We have duplicate vacuum pumps, each having a 4 in. discharge pipe with swing check valve and gate valve between pump and receiving tank. The receiving tank was fairly clean on the inside, but we found what was left of an old hinge and hinge pin from a check valve. This led to an examination of the two check valves in the discharge from the vacuum pumps. The first one opened was found to have the hinge and pin missing, the other had the pin worn through with the clapper and hinge lying on the bottom of the check. It took about five weeks to get new parts including seat rings. To install these seat rings we sawed off a piece of flat steel about 1 in. by ¼ in. and of proper length to fit the inside diameter of the ring, to engage the lugs, and used a monkey wrench to turn it in tight. This was done without removing the valve from the piping. The old ring was removed with a cold chisel and hammer. These check valves had been in service about 18 yr and should have been examined sooner, for wear. They are now about as good as new with everything new except the body.

The Boiler Fireman's Handbook

By J. R. DARNELL

Curves and Tables permit calculation of flue gas weights and volumes as well as boiler efficiencies for various types of fuel

VII. Boiler Efficiency Calculated from Flue Gas Analysis and Temperature

IN PREVIOUS CHAPTERS we discussed methods of sampling and analyzing flue gas in order to obtain accurate CO_2 values. We have also discussed the relationship of CO_2 to excess air, the relationship of actual CO_2 to the maximum theoretical values and methods of measuring flue gas temperatures. We now come to a discussion of the relationship of CO_2 values to boiler efficiency for given flue gas temperature values. We also show weights of flue gas for varying percentages of CO_2 with different types of fuels. It is a simple calculation to translate weight to volume if it is so desired.

Efficiencies Calculated from CO_2 Values

The curves shown in Figs. 1 to 5 were originally prepared to determine CO_2 values for given boiler efficiencies and temperatures. After the CO_2 values are obtained, Tables 1 to 5 may be used to arrive at flue gas weights. However, the procedure may be reversed by starting with a given CO_2 value. For example, referring to Fig. 1, for oil firing, if the flue gas analysis shows 12.3 per cent CO_2, reading upward to the point which intersects the CO_2—Excess air curve, read horizontally to the left along the 30 per cent excess air line to the intersection of whatever flue gas temperature has been observed. If, for example, the temperature is 550 F, at the intersection of this temperature line with the 30 per cent excess air line we read upward to find 76 per cent net efficiency. In like manner, efficiencies can be determined for CO_2 values with other fuels. Figure 2 is to be used with Eastern bituminous coals having approximately an analysis as shown in Table 2. Figure 3 is to be used for coals of the Pittsburgh area as shown by Table 3. With Fig. 4 efficiencies for Mid-Western coals with analysis as shown in Table 4, may be determined. Figure 5 and Table 5 are to be used for wood fuel.

Tables Aid Calculations for Gas Weights or Volumes

Combustion calculations sometimes are necessary to determine the number of pounds of flue gas to be handled per hour and the mean average specific heat of these products of combustion.

To facilitate calculations, analyses representative of various classes of fuels have been selected, and on the basis of these analyses Tables 1 to 5 have been prepared. These tables show respectively per cent CO_2, per cent excess air, pounds of air per pound of fuel, pounds of gas per pound of fuel, mean specific heat of the gas, pounds of water vapor per pound of fuel, and the latent and sensible heat in the vapor.

Pounds of gas for each percentage of CO_2 is the total amount of gas per pound of fuel, and includes both dry gases and water vapor. The values of mean specific heat are calculated for the mixture of dry gases and water vapor between 250 and 800 deg.

Amount of water vapor per pound of fuel is dependent, of course, on the amount of available hydrogen and the moisture in the fuel. For any given fuel this is constant for any percentage of CO_2. This item is given in each table as a matter of interest, and to show the effect of water vapor on the specific heat. Next to last item in each table is Btu of sensible and latent heat of the water vapor. This is given to facilitate heat balance calculations.

As an example of such calculation, referring to Table 1, we find that for 14 per cent CO_2, 16.4 lb flue gas are produced per pound of oil. The mean average specific heat is 0.2571 Btu. To find the total Btu lost up the stack at, say, 550 F, and with air at 80 F, the following equation would be used:

Stack loss in Btu =
$[16.5 \times 0.2571 \times (550 - 80)] + 1255$.
In each table sensible and latent heat of water vapor is figured for air at 80 F.

As another illustration of the use of the tables, supposing that Illinois coal of 11,000 Btu as fired is to be burned at 70 per cent efficiency with a flue gas temperature of 550 F, air at 80 F. The maximum load is to be 1200 hp per hr.

TABLE No. I. REPRESENTATIVE FUEL OIL

ULTIMATE ANALYSIS

Carbon	84.0
Hydrogen	12.7
Oxygen	1.2
Nitrogen	1.7
Sulphur	0.4
	100.0
BTU	18,700

Per Cent CO_2	15.4	15.0	14.0	13.0	12.0	11.0	10.0	9.0	8.0	7.0	6.0	5.0
Per Cent Excess Air	0.0	2.5	9.4	17.3	26.5	37.3	50.4	66.4	86.5	112.0	146.0	194.0
Lb air per lb oil	14.0	14.4	15.4	16.5	17.8	19.3	21.2	23.4	26.2	29.8	34.6	41.4
Lb gas per lb oil*	15.0	15.4	16.4	17.5	18.8	20.3	22.2	24.4	27.2	30.8	35.6	42.4
Mean specific heat of gas 250 to 800 F	.2585	.2580	.2571	.2560	.2550	.2542	.2532	.2520	.2510	.2499	.2489	.2477
Lb water vapor per lb oil	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14
Btu sensible & latent heat in vapor	1255	1255	1255	1255	1255	1255	1255	1255	1255	1255	1255	1255
Lb per cu ft of gas at 65 F	.0761	.0761	.0760	.0759	.0759	.0758	.0758	.0757	.0757	.0756	.0756	.0755

*For mechanical atomization
For steam atomization add 0.5 lb
See Fig. No. 1 for efficiencies and CO_2—Excess air curve

TABLE No. II. REPRESENTATIVE EASTERN BITUMINOUS COAL

(POCAHONTAS, NEW RIVER, CLEARFIELD, GEORGES CREEK)

PROXIMATE —	As Rec'd	Dry	— ANALYSIS — ULTIMATE	As Rec'd	Dry
Moisture	3.2	0.0	Carbon	79.90	82.53
V.C.M.	21.0	21.7	Hydrogen	4.85	4.64
F.C.	69.3	71.6	Oxygen	6.76	4.05
Ash	6.5	6.7	Nitrogen	1.30	1.35
			Sulphur	0.69	0.71
	100.0	100.0	Ash	6.50	6.72
				100.00	100.00
BTU	14,300	14,450			

Per Cent CO_2	18.7	16.0	15.0	14.0	13.0	12.0	11.0	10.0	9.0	8.0	7.0
Per Cent excess air	0.0	16.4	24.0	32.6	42.6	54.4	68.1	84.6	105.0	130.0	163.0
Lb air per lb coal	10.4	12.1	12.9	13.8	14.9	16.1	17.5	19.2	21.4	24.0	27.4
*Lb gas per lb coal	11.3	13.0	13.8	14.7	15.8	17.0	18.4	20.1	22.3	24.9	28.3
Mean specific heat of gas 250 to 800 F	.2488	.2482	.2478	.2474	.2471	.2467	.2464	.2460	.2456	.2452	.2448
Lb water vapor per lb coal	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
Btu sensible & latent heat in vapor	482	482	482	482	482	482	482	482	482	482	482
Lb per cu ft of gas at 65 F	.0791	.0787	.0785	.0784	.0782	.0780	.0778	.0776	.0774	.0772	.0770

*Figured on basis of 25% carbon in dry refuse
See Fig. 2 for efficiencies and CO_2—Excess air curve

The first step will be to find the number of pounds of coal required per horsepower. By the equation:

$$\text{Lb coal per hp} = \frac{33{,}500}{\text{Btu} \times \text{Efficiency}}$$

$$\text{we find that } \frac{33{,}500}{1100 \times .70} = 4.35 \text{ lb coal per bhp}$$

TABLE No. III. REPRESENTATIVE PITTSBURGH BITUMINOUS COAL

(E. OHIO, YOUGHIOGHENY, HOCKING VALLEY)

PROXIMATE — ANALYSIS	As Rec'd	Dry	ULTIMATE	As Rec'd	Dry
Moisture	1.8	0.0	Carbon	74.0	75.40
Volatile Matter	31.0	31.5	Hydrogen	5.2	5.08
Fixed Carbon	57.2	58.3	Nitrogen	1.4	1.42
Ash	10.0	10.2	Oxygen	8.0	6.50
			Sulphur	1.4	1.42
	100.0	100.0	Ash	10.0	10.18
				100.0	100.00
BTU	13,400	13,650			

Per Cent CO_2	18.4	16.0	15.0	14.0	13.0	12.0	11.0	10.0	9.0	8.0	7.0
Per Cent Excess Air	0.0	14.52	21.95	30.4	40.3	51.6	65.1	81.2	101.0	126.0	157.8
Lb Air per Lb Coal	9.66	11.08	11.79	12.6	13.58	14.65	16.0	17.52	19.42	21.85	24.9
*Lb Gas per Lb Coal	10.53	11.95	12.66	13.47	14.45	15.52	16.87	18.39	20.29	22.72	25.77
Mean Specific Heat of Gas 250-800 F	.2501	.2492	.2488	.2484	.2479	.2474	.2470	.2465	.2461	.2456	.2451
Lb Water Vapor per lb coal	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
Btu Sensible & Latent Heat in Vapor	516	516	516	516	516	516	516	516	516	516	516
Wt 1 cu ft Gas at 65 F	.0787	.0783	.0781	.0779	.0778	.0777	.0775	.0774	.0772	.0770	.0769

*Figured on basis of 25% carbon in dry refuse
See Fig. No. 3 for efficiencies and CO_2—Excess Air Curve

TABLE No. IV. REPRESENTATIVE MID-WESTERN BITUMINOUS COAL

(ILLINOIS, INDIANA, W. KENTUCKY, MISSOURI)

PROXIMATE — ANALYSIS	As Rec'd	Dry	ULTIMATE	As Rec'd	Dry
Moisture	9.95	0.00	Carbon	52.80	58.60
V.C.M.	34.76	38.55	Hydrogen	5.75	5.15
F.C.	42.07	46.75	Oxygen	23.88	16.72
Ash	13.22	14.70	Nitrogen	0.92	1.02
			Sulphur	3.43	3.81
	100.0	100.0	Ash	13.22	14.70
				100.00	100.00
BTU	10,960	12,150			

Per Cent CO_2	18.6	16.0	15.0	14.0	13.0	12.0	11.0	10.0	9.0	8.0	7.0
Per Cent Excess Air	0.0	15.9	23.8	31.9	41.9	53.5	67.2	83.6	104.0	131.0	161.0
Lb Air per Lb Coal	6.7	7.7	8.3	8.8	9.4	10.3	11.2	12.3	13.8	15.4	17.4
*Lb Gas per Lb Coal	7.5	8.5	9.1	9.6	10.2	11.1	12.0	13.1	14.6	16.2	18.2
Mean Specific Heat of Gas 250-800 F	.2555	.2539	.2532	.2525	.2518	.2511	.2504	.2197	.2489	.2482	.2475
Lb Water Vapor per lb coal	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
Btu Sensible & latent heat in vapor	572	572	572	572	572	572	572	572	572	572	572
Lb per cu ft of gas at 65 F	.0770	.0768	.0767	.0766	.0765	.0765	.0764	.0763	.0762	.0761	.0760

*Figured on basis of 25% carbon in dry refuse
See Fig. No. 4 for efficiencies and CO_2—Excess air curve

TABLE No. V. REPRESENTATIVE WOOD FUEL

(HOGGED FUEL — MILL REFUSE)

ULTIMATE ANALYSIS	Dry	As Rec'd
Carbon	50.31	27.15
Hydrogen	6.20	8.45
Oxygen	43.08	63.18
Nitrogen	0.04	0.02
Ash	0.37	0.20
	100.00	100.00
Btu	9153	4940
Moisture		46.1

Per Cent CO_2	20.5	18.0	16.0	15.0	14.0	13.0	12.0	11.0	10.0	9.0	8.0	7.0
Per Cent Excess Air	0.0	13.8	27.9	36.4	46.2	58.0	70.5	85.0	104	126	155	192
Lb air per Lb Wood	3.3	3.7	4.2	4.5	4.8	5.2	5.6	6.1	6.7	7.4	8.4	9.6
Lb gas per Lb Wood	4.3	4.7	5.2	5.5	5.8	6.2	6.6	7.1	7.7	8.4	9.4	10.6
Mean specific heat of gas 250-800 F	.2794	.2755	.2725	.2710	.2694	.2678	.2661	.2644	.2627	.2606	.2588	.2568
Lbs water vapor per lb wood	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
Btu Sensible & latent heat in vapor	838	838	838	838	838	838	838	838	838	838	838	838
Lb per cu ft of gas at 65 F	.0724	.0728	.0731	.0732	.0734	.0735	.0737	.0738	.0740	.0742	.0744	.0745

Percentage of ash is so small that even with 25% carbon in dry refuse the loss is negligible
See Fig. No. 5 for efficiencies and CO_2—Excess Air Curve

If the amount of carbon in the refuse is not stated, it is safe to assume an average figure of 25 per cent. Since Illinois coal is classed as mid-western bituminous, we may now refer to Fig. 4, which shows curves of efficiencies for this class of coals. These efficiencies are gross values, and to obtain net values the per cent loss due to carbon in the refuse must be subtracted from curve value. Referring to the lower curve we find that 25 per cent carbon in the refuse gives a loss of 5.85 per cent. Adding this to 70.0 per cent we get 75.85 per cent gross efficiency. Starting at 75.85 per cent efficiency we go straight down until we strike the 550 deg line, and then extend a horizontal line to the CO_2 excess air curve. From this point, going down to the CO_2 base line, we find that 10.6 per cent CO_2 or 72 per cent excess air must be found in the flue gas in order to produce this efficiency. Interpolating in Table 4, or more exactly, from the curve for Illinois coal in Fig. 6 we find that 12.2 lb gas are produced per pound of coal. Since 4.35 lb coal are burned per boiler horsepower, there will be 4.35×12.2 or 53 lb gas per boiler horsepower. Then, $53 \times 1200 = 63{,}250$ lb gas per hr.

Curves Show Weight of Gas Per Cubic Foot

Besides the weight of gas per hour it will be necessary to know the number of cubic feet per minute if it is desired to determine induced draft fan capacity. This is done by dividing the weight of gas per minute by the weight of one cubic foot of gas. In each of Tables 1 to 5 the last item gives the weight of one cubic foot of gas at 65 F for varying percentages of CO_2. For any percentage of excess air corresponding to a given CO_2 value, the exact weight of one cubic foot of gas may be found from the curves in Fig. 7.

In the above cases there are $\frac{63{,}250}{60}$ or 1065 lb gas per min. From the curve for Illinois coal in Fig. 7, we find that for 10.6 per cent CO_2, corresponding to 72 per cent excess air, the weight of gas at 65 deg is 0.0763 lb per cu ft.

Then, $\frac{1065}{0.0763} = 13{,}950$ cu ft per min.

The pounds of air theoretically required with no excess may be found by formula: Lb air at maximum $CO_2 = 11.52\ C_a + 34.56\ (H - O/8) + 4.32\ S$. Where H, O, and S are the percentages by weight respectively of hydrogen, oxygen and sulphur in 1 lb of fuel, C_a is the per cent of carbon, by weight, in 1 lb of fuel which is actually burned. This is obtained by subtracting from the ultimate carbon given in the analysis the amount of carbon in the refuse, calculated as per cent of 1 lb of coal.

In the case of the eastern bituminous coal given in Table 2, if there is 25 per cent carbon in the dry refuse and 6.72 per cent dry ash in the coal, then $1.00 - 0.25 = 75$ per cent ash in the refuse, and $1.00/0.75 = 1.33$ per cent ref-

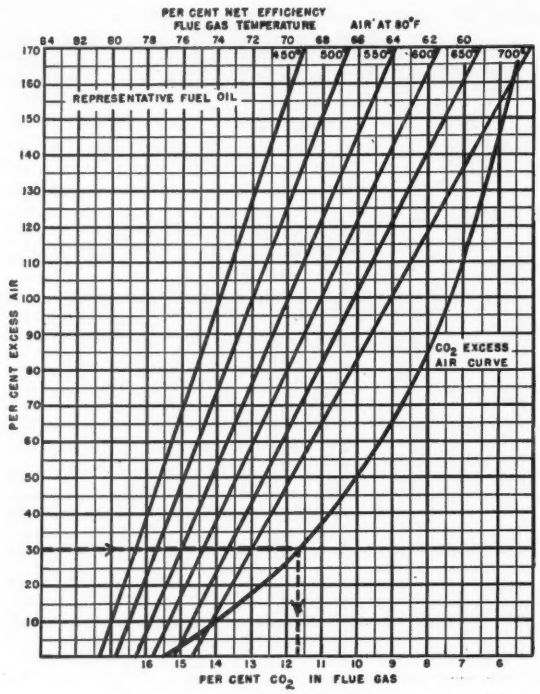


Fig. 1. Chart for representative fuel oils. All losses included. Allowance of 5 per cent for radiation and unaccounted for losses

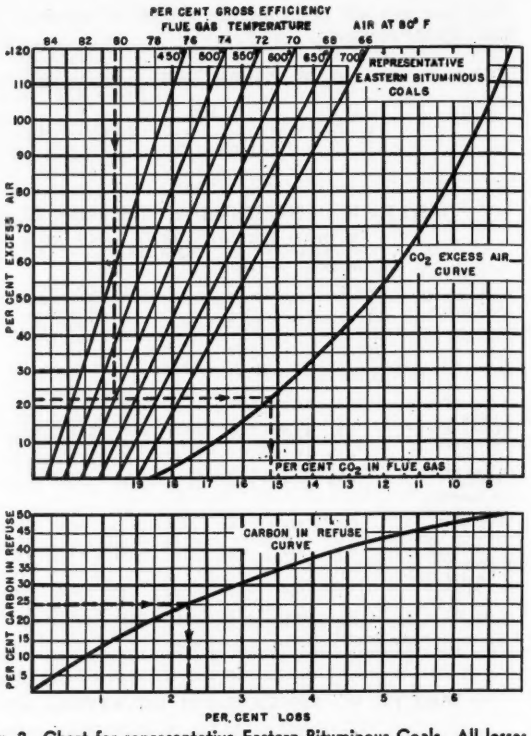

PER CENT GROSS EFFICIENCY
FLUE GAS TEMPERATURE
AIR AT 80° F
REPRESENTATIVE EASTERN BITUMINOUS COALS
CO_2 EXCESS AIR CURVE
PER CENT EXCESS AIR
PER CENT CO_2 IN FLUE GAS
CARBON IN REFUSE CURVE
PER CENT CARBON IN REFUSE
PER CENT LOSS

Fig. 2. Chart for representative Eastern Bituminous Coals. All losses included except carbon in refuse. Allowance of 5 per cent for radiation and unaccounted for losses. Subtract loss to carbon in refuse to obtain net efficiency. Add per cent loss for carbon in refuse to net efficiency to find per cent CO_2 at given flue gas temperature

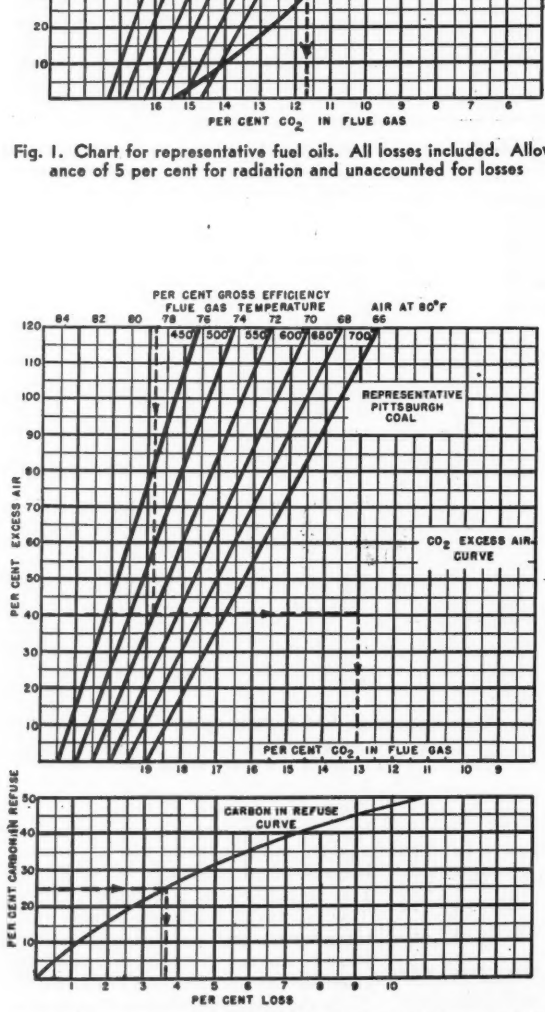


Fig. 3. Chart for representative Pittsburgh Coal. All losses included except carbon in refuse. Allowance of 5 per cent for radiation and unaccounted for losses. Subtract loss to carbon in refuse to obtain net efficiency. Add per cent loss of carbon in refuse to net efficiency to find per cent CO_2 at given flue gas temperature

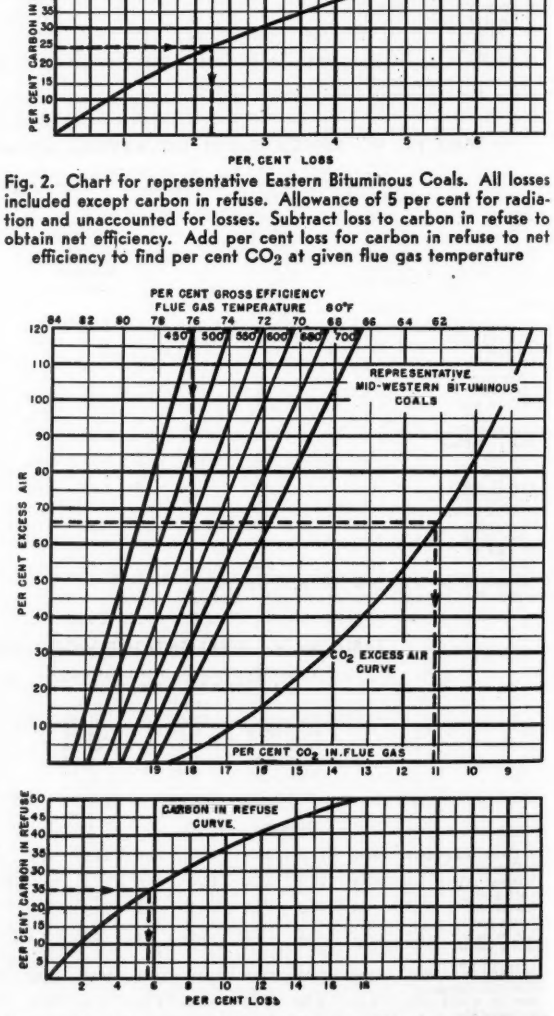


Fig. 4. Chart for representative Mid-western Bituminous Coals. All losses included except carbon in refuse. Allowance of 5 per cent for radiation and unaccounted for losses. Subtract loss to carbon in refuse to obtain net efficiency. Add per cent loss for carbon in refuse to net efficiency to find per cent CO_2 at given flue gas temperature

Fig. 5. (Due to unusual tabular arrangement, Fig. 5 could not be fitted into this page. It will be found on page 98)

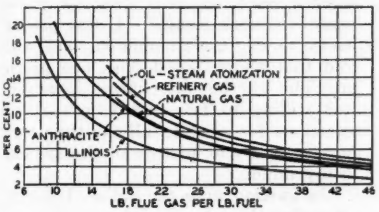


Fig. 6. Flue gas weights for representative fuels

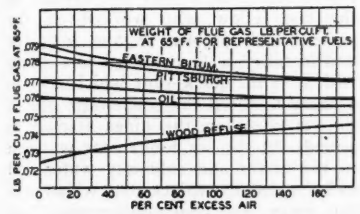

WEIGHT OF FLUE GAS LB. PER CU. FT. AT 65°F. FOR REPRESENTATIVE FUELS
EASTERN BITUM.
PITTSBURGH
OIL
WOOD REFUSE
LB. PER CU. FT. FLUE GAS AT 65°F.
PER CENT EXCESS AIR

Fig. 7. Variation of weight of flue gas at 65 F with excess air for representative fuels

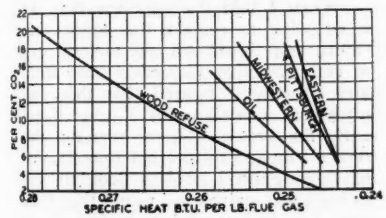


Fig. 8. Mean specific heat of flue gas, 250 to 800 F for representative fuels

use for each 1 per cent ash in the coal. With 6.72 per cent ash in dry coal, $6.72 \times 1.33 = 8.95$ per cent refuse and the weight of carbon in the refuse as a fraction of a pound of dry coal is 0.0895 × 0.25 or 0.0224 lb carbon. Since there is 3.2 per cent moisture in the coal as fired, there is $2.24 \times 0.968 = 2.17$ per cent of each pound of coal found in the ash pit.

The amount of carbon actually burned then will be 79.9 — 2.17 or 77.73 per cent of 1 lb of coal as fired. This will be the value of C_a in the above equation. After calculating the amount of air required for any percentage of CO_2, the amount of gas produced is obtained by adding to the weight of air per pound of coal fired, that per cent of 1 lb of coal which actually passes up the flue. This is found by subtracting from 100 per cent the per cent of ash in the coal plus the per cent of 1 lb of coal found in the refuse. In this case there is 6.50 + 2.17 = 8.67 per cent left behind, or 100.00 — 8.67 = 91.3 per cent of each pound of fuel as fired passes up the stack. Accordingly, 0.91 lb must be added to the weights of air per lb of fuel to obtain the amount of gas per pound of fuel.

The following shows the method of calculating the values of mean specific heat and the weight of gas per cubic foot in the case of eastern bituminous coal:

Carbon burning to CO_2 requires 2.67 lb oxygen
Hydrogen burning to H_2O requires 8.0 lb oxygen
Sulphur burning to SO_2 requires 1.0 lb oxygen

Then:

$0.777 \times 2.67 = 2.08$ lb O_2, $2.08 + 0.777 = 2.857$ lb CO_2
$0.0485 \times 8.0 = 0.388$ lb O_2, $0.388 + 0.0485 = 0.437$ lb H_2O
$0.0069 \times 1.0 = 0.007$ lb O_2, $0.007 + 0.007 = 0.014$ lb SO_2

Total	2.475 lb O_2
Minus	0.068 lb O_2 in the coal
	2.407 lb O_2 supplied per lb coal.

Since there is 1 lb of oxygen in each 4.32 lb air, then: $2.407 \times 4.32 = 10.41$ lb air theoretically required at maximum CO_2 with no excess air. (Note that this method checks with the formula previously given for figuring the amount of air required.)

For maximum CO_2 there is, of course, no oxygen in the flue gas and the weights of the products of combustion are:

Weight of Products, Pounds		Per Cent by Weight		**Mean Sp. Heat 1 lb. of each gas		Mean Sp. Heat of constituents
*CO_2	2.871	0.253	×	0.2185	=	0.0554
H_2O	.437	0.039	×	0.4630	=	0.0181
N_2	8.022	0.708	×	0.248	=	0.1753
Total	11.330	1.000				0.2488 Btu.

* Includes SO_2

** Values of mean specific heat for each gas are averages between 250 and 800 F taken from curves given in Heilos, 27th Edition, pp. 403-405. See also p. 32, Fig. 1, Principles of Combustion by A. D. Pratt.

At percentages of CO_2 less than maximum, oxygen appears in the flue gas along with the nitrogen. At any percentage of CO_2 the weight of oxygen is calculated as follows:

At 13 per cent CO_2, as shown in Table 2, there is 42.6 per cent excess air. Then, since the oxygen and nitrogen in the air are 23.15 and 76.85 per cent by weight respectively:

$10.41 \times 0.426 \times 0.2315 = 1.03$ lb O_2
$10.41 \times 0.426 \times 0.7685 = 3.41$ lb N_2

Weight of Products, Pounds		Per Cent by Weight		Mean Sp. Heat of 1 lb. of each gas		Mean Sp. Heat of constituents
CO_2	2.871	0.182	×	0.2185	=	0.0398
H_2O	0.437	0.028	×	0.4630	=	0.0130
O_2	1.030	0.065	×	0.2200	=	0.0143
N_2	11.432	0.725	×	0.2480	=	0.1800
	15.770					0.2471 Btu.

Values of mean specific heat at various percentages of CO_2 for different fuels are shown in Fig. 8.

The weight of one cu ft of flue gas for 13 per cent CO_2 in the case of eastern bituminous coal, as shown in Table 2, is calculated thus:

Per Cent by Weight			Weight 1 cu ft of each gas at 60 F		Cu ft of constituents at 60 F
CO_2	0.1809	+	0.1164	=	1.550
H_2O	0.0278	+	0.0476	=	0.584
O_2	0.0664	+	0.0846	=	0.784
N_2	0.7249	+	0.0743	=	9.750
	1.0000				12.668 cu ft per lb of gas

$$\frac{1}{12.668} = 0.0789 \text{ lb per cu ft at 60 F}$$

$$0.0789 \times \frac{520}{525} = 0.0781 \text{ lb per cu ft at 65 F}$$

Values of flue gas weight in pounds per cubic foot at various percentages of CO_2 for different fuels are shown in Fig. 7.

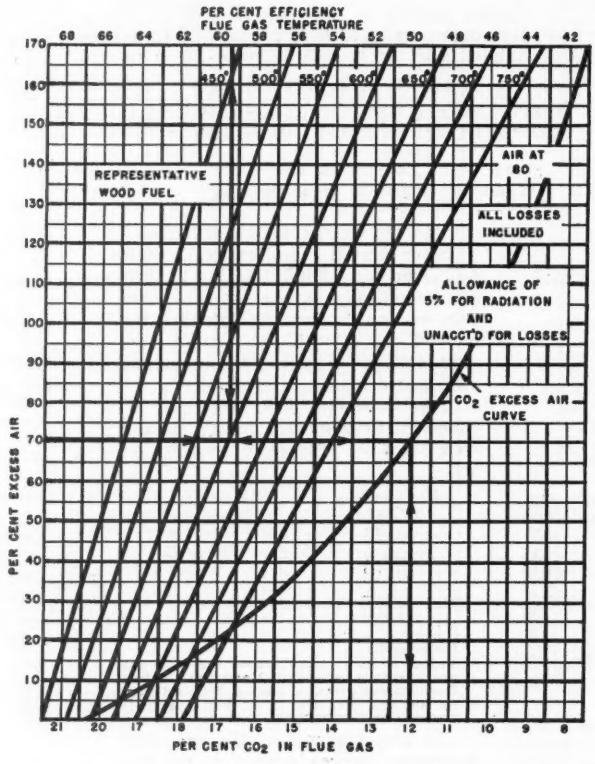

PER CENT EFFICIENCY
FLUE GAS TEMPERATURE
68 66 64 62 60 58 56 54 52 50 48 46 44 42
450° 500° 550° 600° 650° 700° 750°
REPRESENTATIVE WOOD FUEL
AIR AT 80
ALL LOSSES INCLUDED
ALLOWANCE OF 5% FOR RADIATION AND UNACCT'D FOR LOSSES
CO_2 EXCESS AIR CURVE
PER CENT EXCESS AIR
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
21 20 19 18 17 16 15 14 13 12 11 10 9 8
PER CENT CO_2 IN FLUE GAS

Fig. 5. Chart for representative wood fuel. All losses included. Allowance of 5 per cent for radiation and unaccounted for losses. (Boiler Fireman's Handbook, Part VII—refer to pages 95 and 97)

LETTERS AND COMMENTS

Bill Heiwig Reports

As it has been quite a while since I have written anything for Power Plant Engineering, I thought, maybe, I should let the boys know that I am still around and, true to my letter to you three years ago, I have quit the operating game and have gone into the trouble shooting business for myself, which I am getting a big kick out of and what is also important, a lot more money and thanks than I did in the operating field. It certainly does the soul good to know that you are of some help to your fellow engineers.

I was called into the boiler room of a public school last winter to see what could be done to repair a so-called faulty heating system. This was a steam vapor job and they were having a lot of trouble with water hammer and no heat. The pipes pounded so badly with 8 lb steam that the teachers would lead the children out of the building.

I looked the system over and came to the conclusion that the system worked once, so, why couldn't it be made to work again? I was in no hurry to express an opinion, and was told that all the good ones had given up. The old boy in charge, however, was willing to talk and I just asked questions for a while, all the time trying to get a true picture of the system in my mind.

In looking over the boiler, I asked, what that thing over in the corner was and found out that it was the condensate return pump and air eliminator. I was told that it was not needed as the last fellow who worked on the system had removed it and in place had installed a ½ in. bleed line along with a ¾ in. quick vent which was to be used to bleed the condensate out of the return when the pipes started to pound. As the hot condensate was run to the sewer and cold city water had to be added to replace that which was run away, the coal consumption had increased as also had the danger from scale and cracked sections.

When I told the operator that we were going to replace the condensate return trap I did not get any display of enthusiasm or encouragement from him. But as I figured that this was my worry as well as his, I went ahead with the repair. Upon opening the return trap and testing it I found nothing wrong so I took a look at the swing check valves and found that they were in a bad condition, in fact, I replaced them with two new ones. After that I went over the entire system, cleaning and testing all traps on radiators as well as drips. Then I informed the operator that we were ready to fire up and see whether our labors would pay off.

He asked me how much steam I would want and when I said 1 lb I could hear him grunt to himself. I watched the gage and when it started to leave the pin I asked him to go into the class rooms and see if we were getting any circulation in the radiators. He returned with a smile, saying they were all hot and that he heard no noise. By this time the gage was registering 1½ lb and we adjusted the damper regulator for this pressure. I shook hands with him, knowing that I had made a new friend and left to make another new acquaintance somewhere else.

Seymore, Ind. — Wm. F. Heiwig

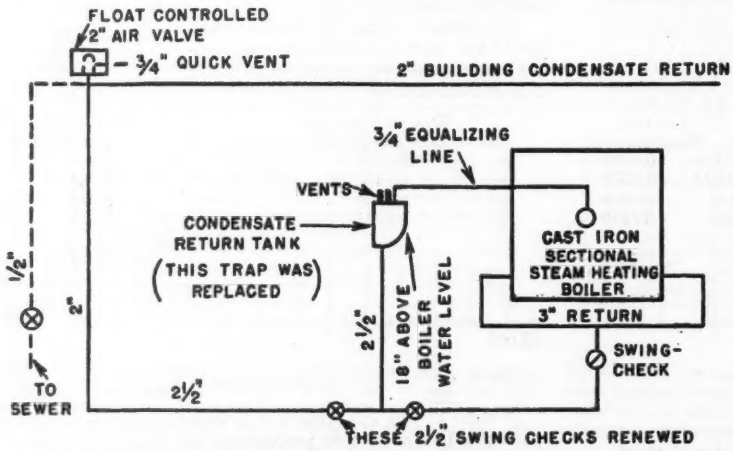


Diagram of heating system. Dotted lines indicate what was used when return trap was removed and before Wm. Heiwig replaced it

W.T.M. and M.J.S. Take Notice

I would not believe for a minute that I am one of the "good chief engineers still about" but I cannot keep still when I read opinions of the nature expressed by W.T.M. and M.J.S.

Why is it that we occasionally read diatribes of this nature but never read "Comments on Incompetent Firemen"? I'll tell you why. It is because firemen provide bright ideas that the

Chief overlooked or never thought of. If a fireman were to discover that his Chief thought of him as incompetent, there would be no more bright ideas, and the Chief would, perforce, languish on his stem. This means of giving the Chief his "come-uppance" seems to be one the bright ones overlooked.

Look me over, M.J.S., because I have never been reluctant to pass on any and all information, no matter how technical, that my staff can absorb. My very comprehensive library is available to them at all times—just last week I *gave* two complete sets to my second trick man. I give the very best and informative answers I know how to give to any question any of my men may ask. On the other hand, I frequently ask their advice and opinion. This is because my second trick man knows more about automobiles, trucks, etc., than I will ever know; and my third trick man is a good mechanic with years of training and experience, which I have never had.

But I am an old man, with nearly all of my engineering behind me. You may say that I have nothing to lose. I am sure that when I am no longer able to stand the gaff, I'll hang up my Stillson, pack away my Crosby, and go where good (if any) engineers go.

Nevertheless, in 36 yr of engineering, I have always followed the same tactics, and not once has anyone gotten my job away from me because I told him all I knew about the plant.

There must be, however, a good many Chiefs who, being human, realize that subordinates have both eyes on the Chief's job and, presumably superior pay, and would do anything to "show him up". No one, not even a fireman, wants to be shown up nor does anyone want to give up a good paying job for a poorer one. Moreover, there is a certain prestige, or so I assume, to the ability to be known as Chief So and So.

I know exactly what it means—just how much "kick" a fireman gets out of telling the Chief something he doesn't know. Believe it or not, I've done it myself, frequently, years ago, of course. I remember a Chief who spent a good many company dollars packing and repacking a duplex boiler feed pump, night after night. He thought the packing bound the rods unevenly. I finally told him it could be a follower bolt on the steam end. It was. I was pretty tickled with this and other episodes and wrote a letter to that effect, to—it might have been P.P.E. It wasn't printed because the Editor thought it might antagonize Chief Engineers. Nowadays it is assumed we Chiefs are not so thin skinned.

Well, M.J.S. and W.T.M., you wanted some fireworks so here they are. Maybe you won't consider them even a damp fire cracker, but, such as they are, you are welcome to them.

A. H. PARKER
"Incompetent Chief" of
Peterborough Hospital.

Questions And Answers

Question No. 287

How Stop Trouble from Sand in Wood Fuel?

STEAM IS GENERATED in our plant at 150 psi in 5 boilers: a 100,000-lb-per-hr gas fired boiler; two wood-refuse burning boilers; two 795-hp standby boilers. We are having trouble in our wood-burning units. Quite a bit of sand comes in with the wood refuse, causing trouble in the furnace because the heat melts the sand, forming a glassy coating which gets onto the furnace walls and causes spalling of the refractories. The same sand gets into the grates and fusing with the ash, prevents free air flow through the grates. Then, too, it builds up in the baffles, affecting the draft.

I suppose the correct way to overcome this difficulty would be to buy some device to separate the sand from the wood fuel before burning. But we can't get the equipment or manpower for this right now. Do you readers have any ideas on what we can do about this problem?

J. J. P.

Question No. 288

How Clean Steel Drums?

WE'D LIKE TO improve our arrangements for cleaning the 55-gal returnable steel drums in which we ship our products. At present we give them an alkaline bath, then douse them in rinse water. But we have trouble with rusting inside the drums. Can Q & A readers give us some practical hints on how to prevent this rusting and on our cleaning procedure in general?

We're also interested in learning more about all these new rust-preventing compounds in general and the experience of engineers in using them. Will they work equally well in tanks where water is flowing and in still water? Do they set up any adverse conditions? We have a lot of water storage tanks around here that need some kind of rust protection.

Chattanooga, Tenn. C. L. H.

Editor's Note:—See description of Carbo Rustex, Front Lines, January, 1945, page 8; also data on Rustarestor, and a number of other rust-preventing compounds described in POWER PLANT ENGINEERING *in the past year or so. A list of these will be sent if desired. Crane Co. has done much work on corrosion as told in May, 1944, Valve World; see also Front Lines, May, 1944, page 7, concerning work of Dr. H. E. Uhlig of G. E. on corrosion.*

Question No. 289

The Mystery of the Missing NH_3

THE THING I've probably given the most study in our plant is this: What becomes of the contents of the cylinder of ammonia, costing $25, that I have to put into our refrigeration system each month? I've gone over the piping and valves with a fine-tooth comb looking for possible leaks and can't find them. I'm mystified. Have Q & A readers had similar experiences? If so, tip me off on what to look for.

We have a plant in which process and heating steam are generated by three 150-hp and one 325-hp stoker-fired boilers. We have a 250-kva engine-driven generator, a 150-kva uniflow unit, a Corliss-engine-driven 50-ton ammonia compressor and also 35-ton and 25-ton ammonia compressors. We have an interconnection with the local utility for night lighting and emergency service. Our plant is merely a big reducing valve, skimming power off the steam before it goes to the processes.

Bowling Green, Ky. W. E. D.

Answer No. 275

What Is P-T Relation at Freezing Point of Water?

The Water Remains a Liquid

THE WATER will remain a liquid no matter how far its temperature is lowered. Most bodies expand on melting and contract on solidifying. But water, cast iron, bronze, and type metal are important exceptions. They expand on solidifying. If, however, this expansion is restrained, freezing cannot occur. Even moderate pressure imposed upon water will perceptibly lower the freezing point.

In further elaboration on this interesting subject—unlike water, all rocks contract on solidifying and expand on melting. Geologists estimate that rocks in the earth's interior are subjected to pressures of 20,000,000 pounds per sq in., which, of course, must raise their fusion-points enormously, and in many cases they remain solid in spite of the high temperature. These temperatures may be at least 10,000 C.

Baltimore, Md. JOSEPH A. KENDRICK

The Water Will Stay Frozen and P increases as T Drops

WATER has its greatest density at 4 C (39.2 F), and at temperatures both above and below this point it expands. At 0 C and atmospheric pressure, wa-

ter freezes; and remains solid at still lesser temperatures, expanding as it gets colder. Table A shows the relative density and volume of water at temperatures from —10 to +250 C; Table B the compressibility of water at various pressures; and Table C the melting point of ice with variation in pressure. (All these tables are from the Handbook of Chemistry and Physics.) Figure 1 is a plot of Table A between the temperatures —10 and +20 C.

Assume that a cylinder is filled with pure water containing no gas and at the temperature of maximum density (4 C) and a piston is screwed down on the water until it makes contact. The water is now still liquid at a relative volume of 1.00000 and exerts zero pressure on the container. If it is then cooled to, let us say —10 C, it will solidify and attempt to expand to a relative volume of 1.00186. Since it is restrained to a relative volume of 1.00000 it is in effect compressed by 0.00186 ÷ 1.00000 or 1860 parts in a million.

From Table B we see that water in the temperature range around 0 C is compressed, for all practical purposes, approximately 50 parts per million per atmosphere of pressure. This means then that the water is exerting a pressure on the container of 1860 ÷ 50 = 37.2 atmospheres or about 546 psi gage. The pressure for other temperatures would be figured the same way.

Table C shows that the melting point of ice is lowered with pressure in pretty nearly a straight line relationship. To melt ice at —10 C requires a pressure of 1155 kg per sq cm or over 16,000 psi. Ice expanding with decreasing temperatures therefore, within a fixed container and subject only to the pressure resulting from its expansion, will remain solid.

Omaha, Neb. ROLAND J. BERTI

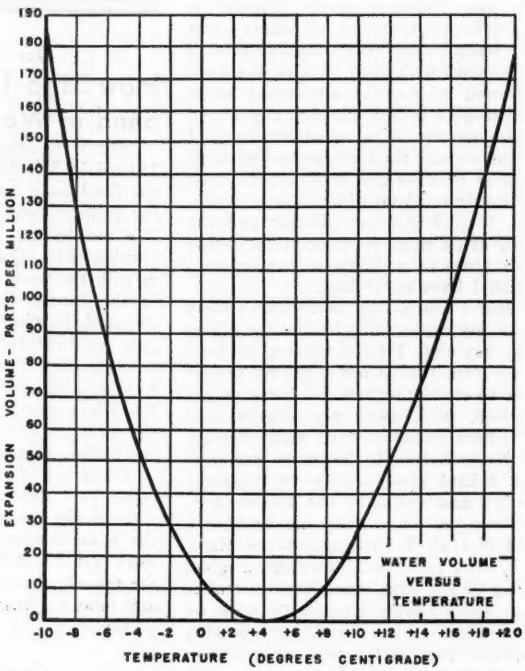


Fig. 1. Graph by Roland J. Berti, plotting relation of expansion and temperature of water between —10 C and +20 C

Table A—DENSITY AND VOLUME OF WATER

The mass of one cubic centimeter of water at 4 C is taken as unity.

The values given are numerically equal to the absolute density in grams per milliliter.

(Smithsonian Tables, compiled from Various Authors)

Temp °C	Density	Volume	Temp °C	Density	Volume
—10	0.99815	1.00186	+35	0.99406	1.00598
—9	843	157	36	371	633
—8	869	131	37	336	669
—7	892	108	38	299	706
—6	912	088	39	262	743
—5	0.99930	1.00070	40	0.99224	1.00782
—4	945	055	41	186	821
—3	958	042	42	147	861
—2	970	031	43	107	901
—1	979	021	44	066	943
0	0.99987	1.00013	45	0.99025	1.00985
+1	993	007	46	0.98982	1.01028
2	997	003	47	940	072
3	999	001	48	896	116
4	1.00000	1.00000	49	852	162
5	0.99999	1.00001	50	0.98807	1.01207
6	997	003	51	762	254
7	993	007	52	715	301
8	988	012	53	669	349
9	981	019	54	621	398
10	0.99973	1.00027	55	0.98573	1.01448
11	963	037	60	324	705
12	952	048	65	059	979
13	940	060	70	0.97781	1.02270
14	927	073	75	489	576
15	0.99913	1.00087	80	0.97183	1.02899
16	897	103	85	0.96865	1.03237
17	880	120	90	534	590
18	862	138	95	192	959
19	843	157	100	0.95838	1.04343
20	0.99823	1.00177	110	0.9510	1.0515
21	802	198	120	0.9434	1.0601
22	780	221	130	0.9352	1.0693
23	756	244	140	0.9264	1.0794
24	732	268	150	0.1973	1.0902
25	0.99707	1.00294	160	0.9075	1.1019
26	681	320	170	0.8973	1.1145
27	654	347	180	0.8866	1.1279
28	626	375	190	0.8750	1.1429
29	597	405	200	0.8628	1.1590
30	0.99567	1.00435	210	0.850	1.177
31	537	466	220	0.837	1.195
32	505	497	230	0.823	1.215
33	473	530	240	0.809	1.236
34	440	563	250	0.794	1.259

Table B—COMPRESSIBILITY OF LIQUIDS

Contraction in unit volume per atmosphere.

Liquid	Temp °C	Pressures in atmospheres	Coefficient	Observer
Water ...	0.	1–25	52.5×10^{-6}	Amagat, 1893
	10.	1–25	50.0	"
	20.	1–25	49.1	"
	0.	25–50	51.6	"
	10.	25–50	49.2	"
	20.	25–50	47.6	"
	0.	100–200	49.2	"
	10.	100–200	46.1	"
	20.	100–200	44.2	"
	50.	100–200	42.5	"
	100.	100–200	46.8	"
	0.	500–1000	41.6	"
	0.	1000–1500	35.8	"
	0.	1500–2000	32.4	"
	0.	2000–2500	29.2	"
	0.	2500–3000	26.1	"

Table C—MELTING POINT OF ICE—VARIATION WITH PRESSURE

(From Tamann, 1900, by permission.)

Pressure in kg per sq cm	Temp °C	Pressure in kg per sq cm	Temp °C
1	0.0	1410	—12.5
336	— 2.5	1625	—15.0
615	— 5.0	1835	—17.5
890	— 7.5	2042	—20.0
1155	—10.0	2200	—22.1

Tables A, B, and C, from Handbook of Chemistry and Physics, showing PVT relations of Ice and Water

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The Treasury Department acknowledges with appreciation the publication of this message by

Power Plant Engineering

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Answer No. 277

Why High Potential to Ground But Little Current?

Primary to Secondary Leakage

THE QUESTION asked by H. E. A. in the November issue states the same condition that I encountered one time, only I did not find it with a voltmeter, but used my hand—and was I shocked!

As his secondary is a three-wire delta system, there is no place where a ground could occur, and get a voltage reading differing by only 5v, from each phase to ground.

If H. E. A. would leave his voltmeter connected while he tries the ammeter to ground, he would find that the voltage was practically zero.

Where the trouble lies is in one of the transformers, a slight leakage from primary to secondary. This would account for the difference of 5v as the secondary voltages of the two good transformers are bucking the leakage current enough to reduce it from 190 to 185.

In my case, the trouble developed after a lightning flash-over, and was found on the terminal block under the transformer cover. After it was cleared, there was no voltage from secondary to ground.

West Cummington, Mass. FRED E. GOULD

Ohm's Law Gives the Answer

THE VOLTAGE from one of the phase wires of the 440-v, 3-phase, 3-wire, delta-connected transformer, to ground was measured by a voltmeter (probably 300 or 600-v scale). Such a meter has a high resistance and will show full scale deflection with a very small current. When the connection is made from the phase wire through the voltmeter to a ground connection, we have the voltmeter, the ground resistance and the insulation resistance and reactance (capacity) in series. A small current, enough to cause a reading (deflection of pointer) of 185 or 190 passes through the voltmeter coil.

If now, an ammeter (5 amp full scale) is put in the circuit we have the ammeter resistance (low), the ground resistance and the resistance and reactance (capacity) of the transformer winding insulation in series. The current that will flow through the ammeter coil will be greater than with the voltmeter in the circuit but will not be enough to cause the ammeter to show a reading, since the 5 amp meter will require almost 1 amp to cause a noticeable deflection. Twenty to 50 milliamperes (a milliampere is a thousandth of an ampere) will cause a 100-v deflection on an average voltmeter (150-v range). This value of current will cause a 200-v reading on a 300-v voltmeter.

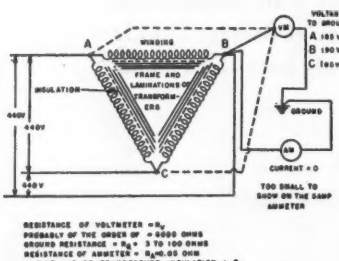
A
B
C
WINDING
FRAME AND LAMINATIONS OF TRANSFORMERS
INSULATION
440V
440V
440V
VOLTMETER
VOLTAGE TO GROUND
A 185 V
B 190 V
C 185 V
GROUND
AMMETER
CURRENT = 0
TOO SMALL TO SHOW ON THE SAME AMMETER
RESISTANCE OF VOLTMETER = R_v
PROBABLY OF THE ORDER OF = 6000 OHMS
GROUND RESISTANCE = R_g = 3 TO 100 OHMS
RESISTANCE OF AMMETER = R_a=0.05 OHM
RESISTANCE OF TRANSFORMER INSULATION = R_t
REACTANCE OF TRANSFORMER INSULATION = X_T = $\sqrt{\frac{1}{\omega^2 C^2}}$
THIS WILL BE HIGH, PROBABLY HIGHER THAN THE VOLTMETER RESISTANCE
$I_a = \frac{E}{R_a + R_g + R_t}$ = MAY BE 20 TO 30 MILLIAMPERES AND WILL CAUSE A READING OF 185 V
$I_v = \frac{E}{R_v + R_g + R_t}$ = 40 TO 60 MILLIAMPERES, TOO SMALL TO GIVE A READABLE DEFLECTION

Diagram by J. E. Wise showing Ohm's law relations in metering insulation

Care should be taken with a low range ammeter. If it is connected from phase to phase or from phase to ground when there is an accidental ground on one of the other phase wires, the current flow will be great enough to burn out or seriously damage the ammeter.

This arrangement, shown in the schematic diagram or sketch below, illustrates Ohm's law. The current depends not only upon the voltage but upon the resistance in the circuit (impedance in an alternating current circuit). I amp = $\frac{E}{R}$ — or — $\frac{E}{Z}$.

Madison, Wis. J. E. WISE

Electrostatic Capacity Explains It

THE POTENTIALS he finds upon these three different wires are due to electrostatic capacity. Every electric circuit has an electrostatic capacity. The law that governs the static capacity of an electric conductor, or a condenser, is covered by the following, in the case of a condenser: the area of the plates or the microfarads, the voltage of the charging current or potential, the frequency or cycles of charging current flowing into the condenser, and the thickness of the dielectric or insulation of the condenser.

If his 4,800/440-v transformers have their cases grounded, there should be no potential from them to ground, which condition we will assume if they are on the ground or foundation.

It is not customary to ground power circuits of 440-v potential. This leaves the three-phase secondary operating at a potential of 440-v above ground; this would include the windings of the secondary in the transformers, the wires and equipment of all appliances, and motors that it serves.

These wires may be considered as an insulated plate of the condenser mentioned above, the insulation of the secondary wires and other equipment would be the dielectric of the condenser, and the 440-v would be the potential charging the condenser.

If his secondary wiring did not include much equipment or cover a large territory to create capacity, his voltmeter readings would be small. The one wire with a reading of 190-v would indicate that this leg might have a little higher insulation, or there may be more capacity due to connected equipment.

The proper use of a "megger" would indicate which of these conditions existed. He will also find that he may get various readings under the same conditions, by using voltmeters of greater or less sensitivity. For instance, using a sensitive voltmeter that would have a high resistance or high ohms per volt, he would obtain a greater reading of voltage, for the current draw would be less than that of a cheap, low-resistance meter.

The fact that these charging currents are so small under your conditions makes this possible. This same small capacity at 60 cycles of charging current, giving the small readings encountered by your voltmeter, would in the case that your frequency was raised to megacycles (millions of cycles) give a capacity that would pass hundreds of amperes, or practically a short circuit.

This would illustrate the effect that frequency has in dealing with capacity effects.

Manhattan Beach, Calif. JESSE F. CLACK

Answer No. 281

Why Couldn't They Magnetize the Wrench?

Must Use Direct, Not Alternating, Current

YOUR DIFFICULTY arises because of the characteristics of alternating current. With a standard 60 cycle a-c source the current in the circuit changes direction 120 times each second. Since the electromagnetic field is set up by the action of the electric current, this field also goes from zero to a maximum in one direction, then to zero and to the maximum in the other direction 60 times a second. This means that if the circuit is interrupted the chance for a strong magnet is very poor. Also if the steel wrench is removed from the coil it goes to a place where the field strength still alternates, but is weaker and it will be practically demagnetized.

In order to magnetize the wrench it will be necessary to have a source of direct current. If the coil has several turns of large wire so it has low resistance, a storage battery may be used. Have a control resistance to avoid too great a current. The theory is that a piece of iron or steel is made up of a large number of very small magnets (molecules). In order to have a permanent magnet, these molecular magnets must be lined up with their north (north seeking) poles all pointing the same way. By using direct current, the field will tend to attract the small magnets and line them up so as to produce a permanent magnet. The hardened steel should be satisfactory for such a magnet.

For demagnetizing tools the coil which you previously used should be satisfactory. The alternating current should be large enough to give a strong field. Place the tool to be demagnetized in this field, then either withdraw it to a distance slowly or reduce the current slowly to zero. Use a control which does not break the circuit as the current is reduced.

See item headed "A-C Arc Welder Demagnetizes Tools" on Page 106 of the December, 1944, issue of POWER PLANT ENGINEERING.

Madison, Wisc. J. E. WISE

Riqid *TESTS* at every vital step in production quard the dependable

QUALITY OF LUNKENHEIMER VALVES

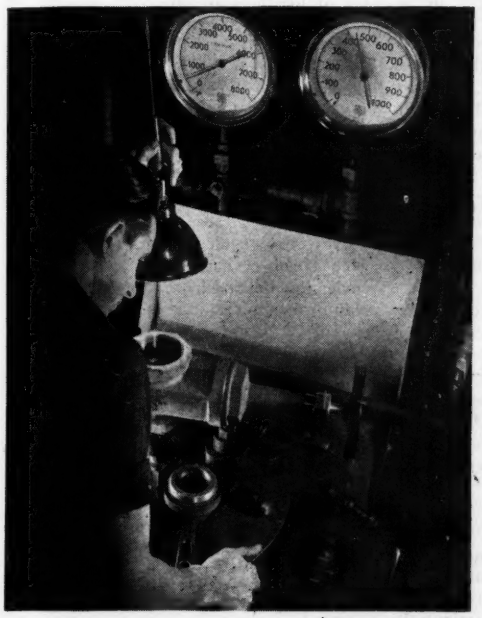

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Fig. 2125
125 lb. S. P. Bronze Gate
Double Disc, Rising Stem

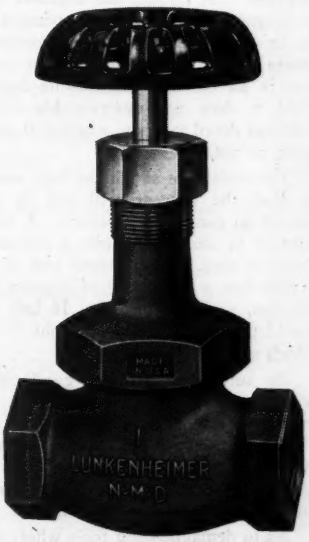


Fig. 123
"N-M-D" Globe (Non-Metallic Disc)

BRONZE, IRON, STEEL AND CORROSION RESISTANT ALLOY VALVES, 125 TO 2500 LB. S. P.; BOILER MOUNTINGS, LUBRICATING DEVICES, AIRCRAFT FITTINGS

Must Use D-C, Not A-C, to Magnetize Wrench

THE REASON V.M.S. was unsuccessful in making his socket wrench into a strong permanent magnet was his choice of a-c fields. The hardening of steel makes it a better magnet, but, with a-c the poles change with every change in the direction of the current. When he gradually withdrew the tool from the field, there was a gradual weakening of the pole, and, when the tool was withdrawn completely from the field the wrench should have been neutral. This is exactly the method many people use to demagnetize watches. It is no wonder that this method failed to give results.

The second method, that of shutting off the current, was a little more successful but only by accident. Since the poles change with each change of current, it would have been just as possible to have shut off the current as the poles were neutral.

To make a strong magnet, it takes a d-c field or contact with a strong magnet.

Magnetized tools are not always effective in such applications because the magnetic force is extended to the other pieces of steel or iron. As the bolt would hit the case, there would be a tendency for the bolt to stick to the case as well as to the wrench. It is more difficult to lift a small piece of iron from an iron work bench than from a wooden bench with a magnet. In some of these cases a "snap-on" type tool is more convenient. Also the tool may be peened to the bolt just tight enough to stay, or adhesive material may be used to stick the bolt to the tool.

Must Use DC to Magnetize

V. M. S. certainly must use direct current to magnetize his wrench. I am surprised that he had the slightest trace of magnetism left after applying alternating current to his coil. A convenient source of d-c, available to almost everyone, is an ordinary automobile battery. V. M. S. does not describe his coil in sufficient detail to know whether it would serve or not.

The resistance should be high enough so that the current will not be high enough to damage the battery. A resistance of ¼ ohm would give a current of about 25 amp. One-hundred feet of No. 4 wire has a resistance of slightly over ¼ ohm, or 100 ft of No. 18 bell wire would permit a current of about 10 amp which should be sufficient.

Be sure that you get good contact with the battery terminals or the contact resistance may be higher than that of the coil. Apply the current for about 10 or 15 seconds, at the same time tapping the wrench with a light hammer and you should get a good magnet.

As to demagnetizing tools where magnetism is undesirable, apply alternating current to the coil and withdraw the tool slowly. But do not apply 110 v to a coil such as described above. The resulting current would be so great as to burn it up.

Philadelphia, Pa. R. E. BUFFINGTON

Answer No. 282

Should He Install Motor Drive or Direct Turbine Drive?

Use Centralized Power Generation, Motor Drive

THIS PROBLEM of M. H.'s is really two: (a) Should he use a machine as a reducer?; (b) Should he use a single or multiple installation?

Taking the worst of the conditions and figuring that the power would be generated from the 110 psi saturated steam and that the exhaust would be 10 psi, a horsepower-hour could be developed for 5090 Btu at 50 per cent efficiency. A water rate of 86.0 lb per hp-hr would be expected. This power is not obtained for nothing and for every Btu obtained by this method will require 5 to 10 per cent more boiler capacity than if the steam is reduced through a reducing station. Also a reducing station gives a superheated steam that materially cuts the transmission losses, although it does no particular good in contact heaters. For this discussion it is to be assumed that the boiler capacity is there and the line losses can be tolerated.

With the fuel costs at 30 cents per million Btu, power at 1.2 cents per kw-hr, 6000 hours of operation a year, and ten years to amortize the investment, the saving in power would justify an installation costing $600 per kw capacity. This would easily cover the cost of the most expensive a-c or d-c system. Power generated from expanding steam that can be used in process is nearly always economical.

The efficiency of a large single unit is better than that of small units even if the larger unit is not fully loaded. Electric drives are not particularly more expensive than turbines and the efficient speed range is a little greater. The electric control of speed is smoother, more convenient to locate, cleaner, and easier designed than individual steam drives. Centralized power permits the plant to be altered and enlarged and saves a myriad of pipes, traps and expansion joints.

Probably the strongest reason of all to choose centralized power generation is for the convenience of tying to the local utility at very nominal fee for standby service.

In summary, (a) By all means use a machine to reduce steam pressures in place of throttling stations, and (b) use centralized power generation with a-c or d-c distribution to motors for the maximum efficiency, reliability, flexibility and control.

Hermosa Beach, Calif. BILL MADDOCK

Use Induction Motors and Variable Speed Transmission

THE STEAM TURBINE is a very inefficient machine when operated below its rated speed and operates best, under governor control, at a constant speed. A paper machine requires close speed control and can be operated most effectively by controlling speed of all units from any station on the machine. Steam turbines could not be so closely controlled without expensive and cumbersome remote control apparatus. Variable-speed a-c motors are inefficient and have poor speed range; d-c motors could be made to fill the requirements but would be very expensive and would require a d-c generator in the plant.

The cheapest and most effective drive combination is the a-c induction motor coupled to a variable-speed transmission such as the P. I. V. drive. Speed change is made by operation of a small speed change motor, under push button control, on the vari-speed unit. Push buttons can be arranged to control from a number of locations as required.

The most efficient utilization of the steam going to the paper machine jackets could be made by installing an additional a-c generator to compensate for the paper machine load and exhausting at the required jacket pressure. Best operation would be realized by putting the generator on the plant bus rather than attempting an individual combination. An atmospheric back-pressure valve set to required limits would assure free steam exhaust from the turbine under low heating load.

San Francisco, Cal. A. YEATES

Answer No. 283

Why Is Water Level Hard To Control?

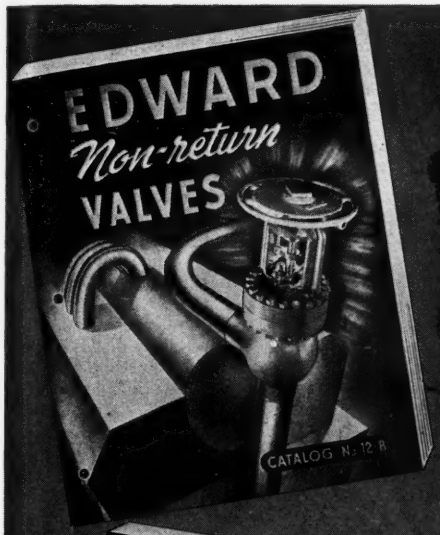
Shrinkage and Swelling of Boiler Water With Load Changes Is the Cause

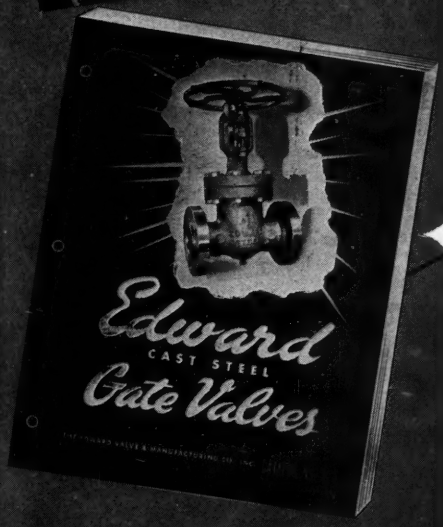
I THINK G. B.'s problem lies in the fact that he has an irregular load and a boiler equipped to pick up load extremely fast. Whenever a load is thrown off a boiler, shrinkage of the boiler water will result. Further shrinkage will take place upon the forced and induced draft fans slowing down and the stoker feed rate decreasing. When this condition occurs, the feedwater regulator will open and the boiler will begin to take water. When the proper level has been reached the regulator will close.

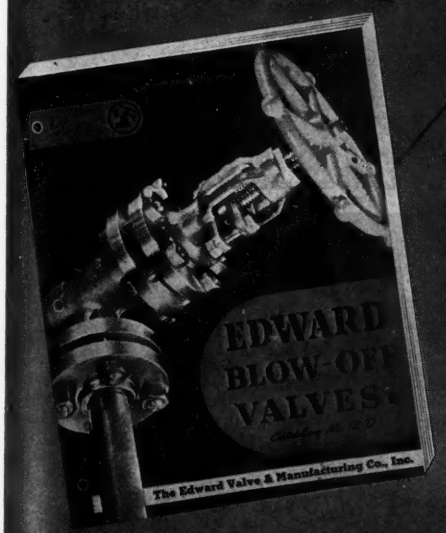
Now, G. B.'s irregular load will come in. Upon a slight drop in steam pressure the boiler water will expand. Further expansion takes place when the stoker and forced and induced draft fans endeavor to pick up the load. The spreader stoker will release a very large amount of heat rapidly. This rapid heat release, coupled with the drop in steam pressure will cause the normal water level to rise until it is at a height which may cause carryover.

G. B. may have combustion control installed and if the newer unit is set to carry a larger percentage of the load, the above conditions will be more pronounced. The older units will not be subjected to a very great amount of "off and in" load. If they are equipped with a stoker which carries a large fuel bed, then fuel bed conditions will take a longer time to change than in a spreader stoker. This will practically eliminate swell which results when more coal is fed into the furnace.

Detroit, Mich. CASPER E. HACKEM







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FOR THE PLANT ELECTRICIAN

What Do You Know About Compensating Windings?

By C. LYNN

Manager, D-C Generator Engineering Dept. Westinghouse Electric & Mfg. Co.

FIGURE 1 shows a stator of a non-compensated d-c generator. The main pole has a smooth face and the commutating poles are located between the main poles. The main shunt and series field coils provide excitation for producing the main pole flux. The commutating field coil provides excitation for the commutating pole and must be sufficiently strong not only to neutralize the field strength of the armature, but to force the commutating flux across the commutating pole air gap into the armature for commutation purposes.

Figure 2 shows a stator of a compensated d-c generator. The construction is similar to that of Fig. 1 except that slots are punched in the pole faces of each main pole through which compensating bars or windings extend. These bars are connected in series with each other in such a manner as to be concentric around each commutating pole. In other words, the compensating winding can be considered as turns taken off of the commutating field coil, spread apart, and buried in the pole face, still surrounding the commutating pole. Comparing Fig. 2 with Fig. 1 it will be noted that the commutating field coil itself has only about half as many turns, with the compensating winding acting as the remaining turns.

The magnetic field, per pole pitch of the armature, set up by the current in the armature conductors opposes and distorts the main field set up by the excitation of the main pole, in the case of the non-compensated machine. This causes a net loss of main pole flux with load current, giving a poor voltage regulation curve for a generator or a poor speed regulation in the case of a motor. In a compensated machine, however, the compensated windings are so proportioned that they will oppose this armature field, varying in strength with it since the compensating winding is connected in series with the armature. Thus the turns in the compensating winding serve two functions: (1) as part of the commutating pole winding, and (2) as neutralizing turns to oppose and eliminate the armature reaction. By doing the latter, they leave the main field practically undistorted and unchanged in shape and strength and improve the shape of the voltage regulation and speed regulation curves for d-c generators and motors. The compensating winding also serves another purpose and that is to improve the overload commutating capacity of a d-c machine by reducing the amount of leakage flux from the commutating pole to the main pole, since these turns lie physically outside of this leakage flux path. Compensating windings add to the cost of a machine and are, therefore, used only in those cases where the performance required justifies its use.

Figure 3 shows the stator of a synchronous converter with damper windings located in the main pole face. The damper windings are bare copper, short circuited upon themselves, and the current in them is produced "inductively" by the magnetic field of the rotor cutting them. The conductors are smaller in size

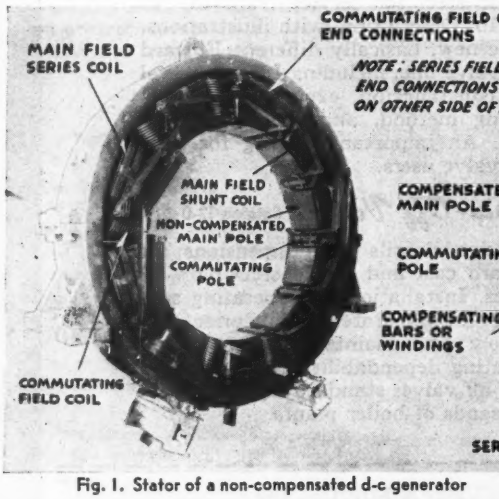
MAIN FIELD SERIES COIL
COMMUTATING FIELD COIL END CONNECTIONS
NOTE: SERIES FIELD COIL END CONNECTIONS ARE ON OTHER SIDE OF STATOR
MAIN FIELD SHUNT COIL
NON-COMPENSATED MAIN POLE
COMMUTATING POLE
COMMUTATING FIELD COIL

Fig. 1. Stator of a non-compensated d-c generator

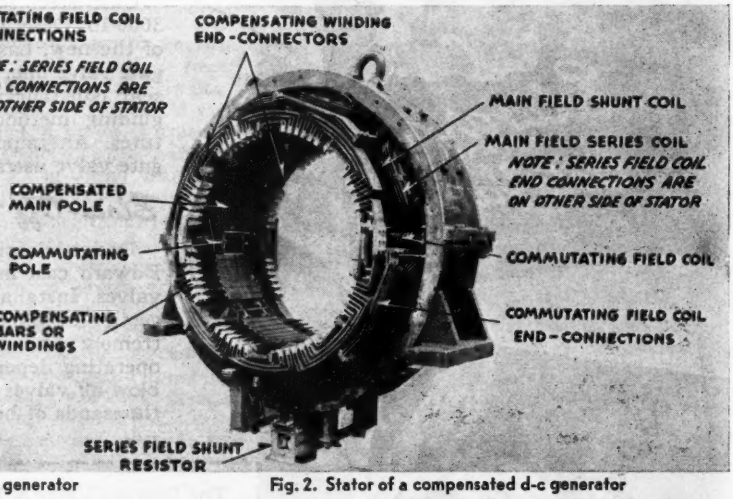
COMPENSATING WINDING END-CONNECTORS
MAIN FIELD SHUNT COIL
MAIN FIELD SERIES COIL
NOTE: SERIES FIELD COIL END CONNECTIONS ARE ON OTHER SIDE OF STATOR
COMPENSATED MAIN POLE
COMMUTATING POLE
COMMUTATING FIELD COIL
COMPENSATING BARS OR WINDINGS
COMMUTATING FIELD COIL END-CONNECTIONS
SERIES FIELD SHUNT RESISTOR

Fig. 2. Stator of a compensated d-c generator

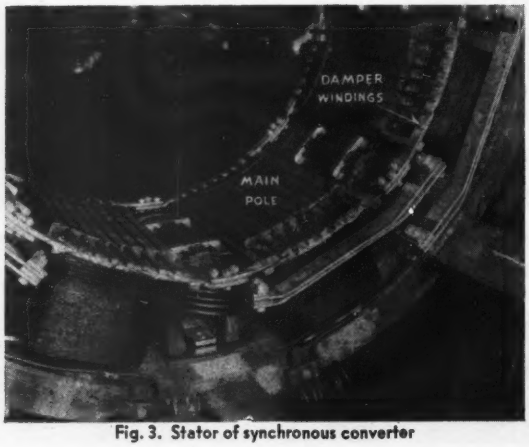

Fig. 3. Stator of synchronous converter

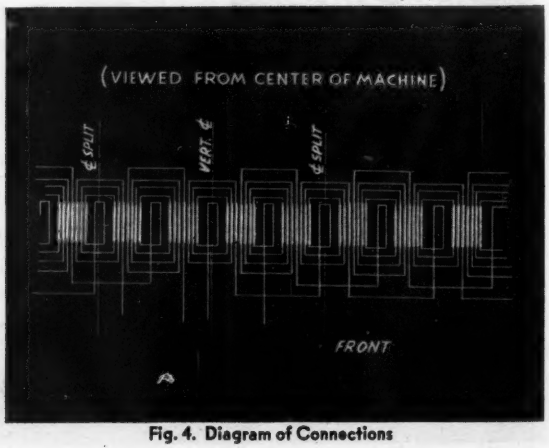

Fig. 4. Diagram of Connections

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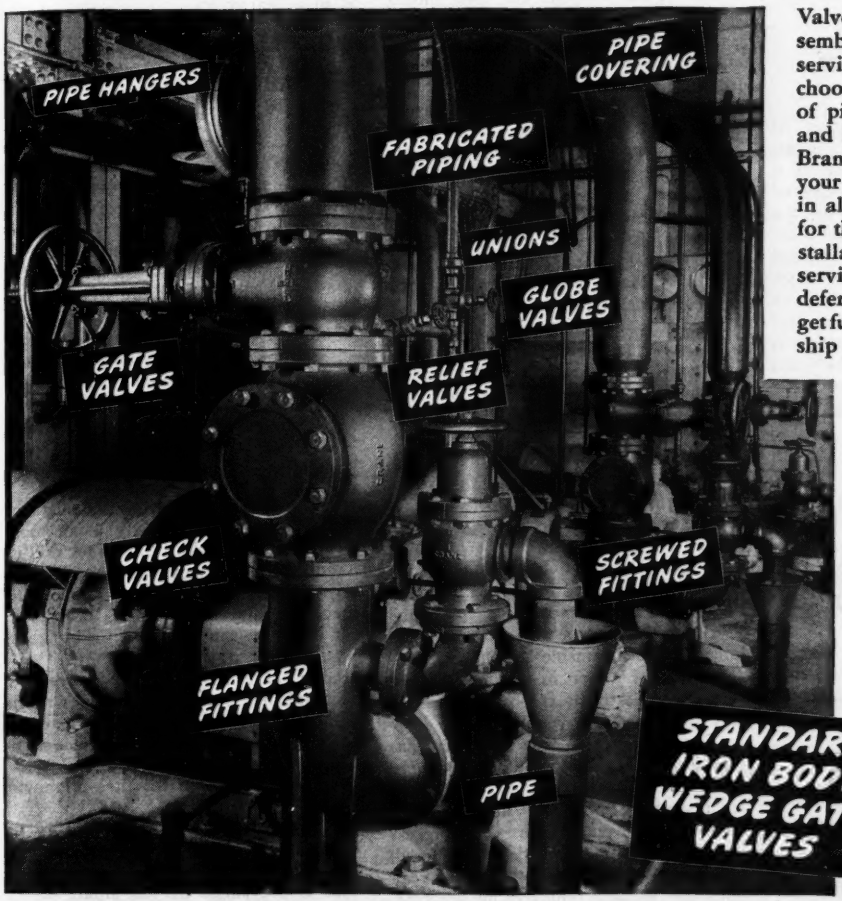

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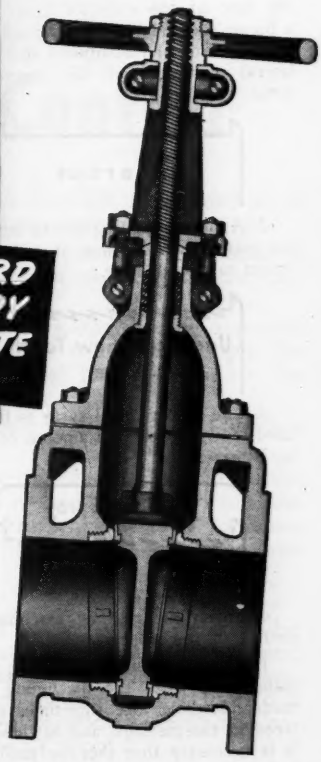

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	Saturated Steam	Cold Water, Oil, or Gas, Non-Shock	Cold Water or Gas Non-Shock
2 to 12 in.	125 pounds	200 pounds	200 pounds
14 and 16 in.	125 pounds	150 pounds	150 pounds
18 to 24 in.	*	150 pounds	150 pounds

*For steam lines larger than 16-inch, Crane 150-pound Cast Steel Gate Valves are recommended.

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than those of the compensating windings because the duty upon them is much lighter. The compensating winding has to be insulated where it goes through the slots in the pole to stand full line voltage to ground, since this winding is "conductively" excited by being connected in series with the armature of the d-c machine, thus carrying full line voltage and current.

Figure 4 is a diagram showing connections of commutating and compensating field windings.

Metalizing of Collector Rings

METALIZING, or the application of metals by spraying is not new to industry. However, there is one phase of it where there seems to be a shortage of factual information. This involves the metal spraying of copper onto brass (cast alloy) collector rings for wound rotor motors, rotaries, and the like. Such a procedure has been followed in a Westinghouse repair shop for the past six or seven years. Every indication is that the copper application on the brass rings has been satisfactory.

The procedure in doing this work, consists of:

1. Take a cut about $\frac{1}{8}$ in. deep on the face of the collector ring, leaving a lip on each edge. The purpose of this lip is to form an additional seal against lateral movement of the sprayed material.

2. Apply a roughing tool to the undercut portion, which leaves it with an undercut saw tooth edge.

3. The copper metal spray is then applied until the required amount of build-up is present.

4. Finish the ring by machining the surface of the copper.

In this procedure it will be appreciated that when the machining cut is made, blowholes are sometimes encountered in the castings, and in these cases it is necessary that they be sandblasted before the metal spray is applied so that good adherence of the copper will be maintained.

This procedure lends itself admirably to the war effort at this time, as collector rings scheduled for scrapping can be rebuilt, and in addition, the rebuilding time is quite often much less than that required to obtain new rings.

This brief article on metalizing of collector rings is printed here with the thought that it may be of assistance to some of our readers; also, for the purpose of gaining any added experience that our readers may be able to supply.

Safety in Cleaning Organic Solvent Tanks

THE CLEANING or repair of tanks in which organic solvents are used should not be undertaken without rigid precautions, inasmuch as the vapors of all organic solvents are toxic and the majority are flammable as well. Oxygen deficiency in the tank is another hazard which must be considered.

If a tank has contained a flammable solvent, the safest method for removing the vapors, preparatory to cleaning or repair, appears to be thorough flushing by steam, followed by mechanical ventilation of a type approved for flammable vapors. Steam jets to loosen sludge have been successful, the tank then being washed, drained and dried out with warm air. If the use of steam is impractical, the sludge may be washed out with high-pressure hose but care must be exercised to avoid building up static electricity. Steam also has some disadvantages, such as the building up of combustible mixtures at the vents. Non-sparking shoes and tools, vapor-proof lamps, and protective clothing should be utilized, and otherwise the Code for Flammable Liquids and Gases of the National Fire Protection Association should be observed.

Before cleaning a tank that has contained a non-flammable solvent, the concentration of vapor in the tank should be reduced as much as possible, preferably by mechanical ventilation.

The cleaning of any tank that has contained an organic solvent should be done from outside the tank, if possible. In degreasing processes utilizing non-flammable solvents, where the process is wholly or substantially enclosed, metal chips, mud, and other solid residues are usually removed by scraping, and a clean-out door is generally provided through which the sludge may be removed by a long-handled scraper. The liquid residue and sludge are immediately confined, to lessen volatilization of the solvent in the atmosphere.

If cleaning from the outside is not possible, before entry into the tank, an air test by a competent chemist is advisable. Workmen who must enter should be further protected, preferably by air-line respirators approved by the U. S. Bureau of Mines for the purpose, though, in some cases, canister type gas masks approved for organic vapors may be used. Protective clothing should be afforded and there should be stationed outside the tank a watcher holding a rope or harness attached to the person inside, in order to haul him out at the first sign of trouble. Removal of protective apparatus should not be permitted until workmen are safely outside the tank.

Whether the tank is cleaned from the inside or outside, however, workmen in the surrounding area also should be protected from the possibility of vapor inhalation or the outbreak of fire. All organic vapors are heavier than air and tend to settle in low places, so that the atmosphere may be practically free of vapors at breathing level and yet contain a mixture that is explosive or hazardous to health at or near the floor or in a nearby pit.

Why Not Be a Good Mechanic?

By Thomas Trail

THERE ARE MANY mechanics, but how many are exceptionally skilled? Probably only a small percentage. I do not mean this article to reflect upon the ability or the conscientious work of mechanics in general. Some probably have an inherent skill in mechanical work and in the handling of the tools used in such trades. Consequently, it is not fair to assume that all should possess the same ability any more than that all musicians should equal the skill of Kreisler or Paderewski. But I should like to point out that it is probably possible for the average mechanic to acquire at least some additional skill if he will earnestly strive to do so.

As an example, there is considerable difference between merely using tools and using them skillfully. The skillful handling of tools can be compared to any other form of artistry. A skillful mechanic is really an artist. A wrench, for instance, can be used in a bungling manner or it can be handled with studied care so that each movement accomplishes something. The wrench can be moved just the right distance so that the jaws settle in place each time and the maximum turning action is accomplished with the minimum effort.

Another example is the use of an ordinary screwdriver. A careless mechanic will probably use a screwdriver that is too large or too small rather than take the trouble to procure one of the proper size. He will likely also not take care to keep the screwdriver blade firmly in the screw slot, and, as a consequence, will damage the screw by allowing the blade to jump out of the screw slot. On the other hand, a careful, skillful mechanic will select the right size screwdriver, will carefully keep the blade centered in the screw slot, will maintain sufficient pressure on the blade to prevent it from jumping out of the screw slot, and will tighten the screw just enough and not twist the head off.

And the same applies to every phase of mechanical work. If a mechanic will devote himself constantly to the effort of daily improving his ability he is sure to see some self-improvement. As always, it is the little details that count, and by taking care in performing each of them he will gradually acquire the skill that will make him an artist in his work.

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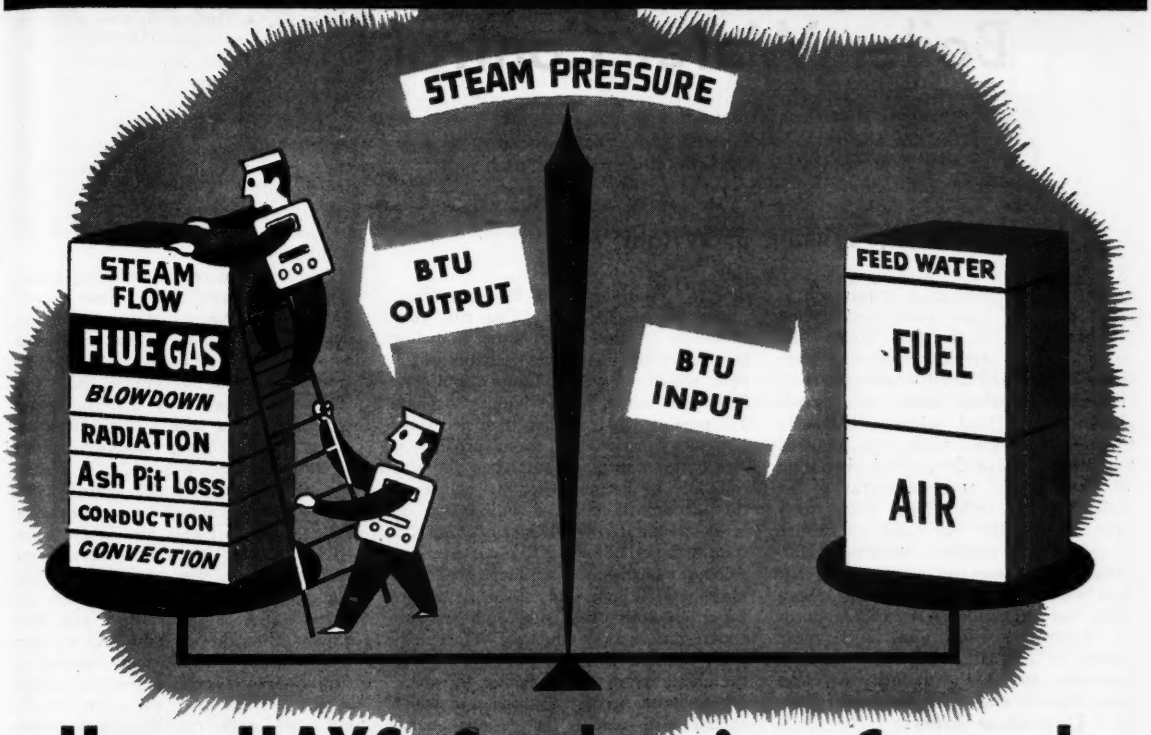

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Practical Methods in Boiler Water Control

A common sense discussion explaining how you can make your alkalinities and total solids behave . . . Facts regarding softener lime control . . . Erratic proportioners and how to handle them . . . Importance of raw water tests

By William J. Wright

WHEN YOU engage a consultant to take charge of your water conditioning problems, one of the first things that he does after carefully analyzing your water supply and plant conditions is to recommend certain limits as regards alkalinity and total solids. Ordinarily the amount of total solids that could be tolerated would be determined by closing all blow downs and concentrating the boiler water to such a point where carry over is excessive. In some plants due to design and peculiar operating conditions this is necessary. However, the American Boiler Manufacturers Association has suggested a set of standards to determine what total solids can safely be carried at certain operating pressures, and in the majority of cases these figures will work out satisfactorily. They are as follows:

Up to 300 psi, ga	3500 ppm
301 to 450 psi, ga	3000 ppm
451 to 600 psi, ga	2500 ppm
601 to 750 psi, ga	2000 ppm
751 to 900 psi, ga	1500 ppm
901 to 1000 psi, ga	1250 ppm
1001 to 1500 psi, ga	1000 ppm

Of course the average engineer has neither the time nor facilities to regularly make determinations for total solids so the consultant will no doubt set up some other method of determination such as a relationship between either chlorides or sulphates, and the total solids depending on which one he considers to hold the more constant relationship. For instance he may decide that for every part per million sulphate you will have three parts per million total solids. He will also set up certain limits of alkalinity. High enough to keep down scale formation but low enough to avoid caustic embrittlement. He may even suggest the use of an embrittlement detector to determine whether or not your water is of embrittling character. Furthermore he will suggest that you keep a certain amount of residual phosphate in the boiler to make sure that all the remaining hardness is converted to tricalcium phosphate. In addition to this ASME standards recommend that you carry a certain sulphate carbonate ratio to further preclude the possibility of embrittlement.

Let us take an example—Suppose you were instructed to keep your alkalinity between 300 and 500 ppm, your total solids below 3500 ppm which would mean say 1200 ppm sulphate. You are to maintain a sulphate carbonate ratio of 2 to 1, and you are to keep a residual phosphate of 30 ppm. You run your titrations on the boiler water and find the following condition: Alkalinity 350 ppm which is within limits. Sulphate 2000 ppm which is too high, phosphate 150 ppm which is higher than necessary but not objectionable. Your problem is clearly to reduce the sulphates and this can only be accomplished by increasing the amount of blow down. After increasing the blow down you find this condition: Alkalinity 200 ppm, too low, sulphate 1200 ppm, within limits, and phosphate 50 ppm which is also satisfactory. In both cases your sulphate carbonate ratio was satisfactory. To remedy this condition you will have to increase the alkalinity in the feedwater by carrying a higher excess of soda ash which should also reduce the residual hardness. However, in a day or so you are again in trouble and find this condition:

Alkalinity 500 ppm which is within limits, sulphate 900 ppm in itself OK and phosphate 75 ppm which is OK. The whole trouble now is that the sulphate carbonate ratio is too low. As you do not want to send any more water to blow down than is absolutely necessary, the first thing to do is to reduce the amount of blow down until you have built the sulphate content closer to the limit of 1200 ppm, but in order to do this without further aggravating the low sulphate carbonate ratio, and at the same time get the alkalinity too high, it will now become necessary that you decrease the alkalinity in the feedwater by reducing the soda ash charge. When you do this you are going to have harder feedwater and as more of the softening will take place within the boiler more phosphate will be used up. However, the decreased blow down will take care of some of this but if your residual phosphate is too low the only answer is to feed in an additional amount.

With some waters this later condition may get so bad that it will be necessary to feed sulphuric acid or nitre cake.

A few words regarding the softener lime control. Do not carry too high excess lime as it only increases the calcium content in your water and may add to your troubles. In fact the nearer to zero you can carry the lime control (no hydrate, no bicarbonate) the better, letting all your excess treatment be in the carbonate form.

I have found that the hardest thing to handle in connection with a water softener is an erratic proportioner. Just as soon as the feed of solution increases or decreases in relation to the amount of water fed, the lime control will at once go out of line. The soda ash control does not get out of line so soon due to the fact that a higher excess is carried, but will be affected to some extent especially if the proportioner is very far off. By all means keep the proportioner functioning properly. You just cannot do a good job of water conditioning otherwise.

Another item of extreme importance is your raw water tests. Your consultant will tell you to operate your softener according to your feedwater control recommendations. That is the correct way, but sometimes your raw water can change very materially over night and it is a wise operator who can detect these changing conditions before the water gets to the softener or boilers.

Your number of boiler water concentrations are calculated by a comparison of the amount of chlorides in the boiler to that in the feedwater. You figure the amount of blow down from this. The oftener you check the boilers for chlorides the closer control you have on your blow down. You may set your blow down in the morning figuring on a certain boiler load. However, before the day is over half the plant may be shut down or the conditions may reverse and double the amount of steam be required. I recommend that samples of boiler water be drawn every 4 hours and chloride determination made. It would be a simple matter to set up a burette convenient for the boiler operator. He would only have to report the number of cc of reagent used and the engineer would know at once the trend of the boiler concentrations.

Close control is most desirable. How many of you have had to turbine hard scale from tubes, or replace tubes at the most inopportune times? Or have to wash out boilers every few weeks. None of this is really necessary, and let me say right here that if you carry your control at least *close* to that recommended by your water consultant, you can keep that boiler on the line for unbelievable periods and when you do finally open it up you will find it clean as a whistle.

For operators who would like to have a visual guide, I have prepared two charts which are shown on page 112 of this issue. One of these is for use where sulfates and alkalinities are reported as parts per million of sodium sulfate and sodium carbonate respectively. The other chart is for use where sulfates are reported in parts per million of the sulfate radical and alkalinities as grains per gallon of caustic alkalinity, as some of the better known consultants do. Both charts are quite accurate and they can be arranged for any set of conditions.

These charts, so far as I know are entirely original and they should be of particular value to the average operator.

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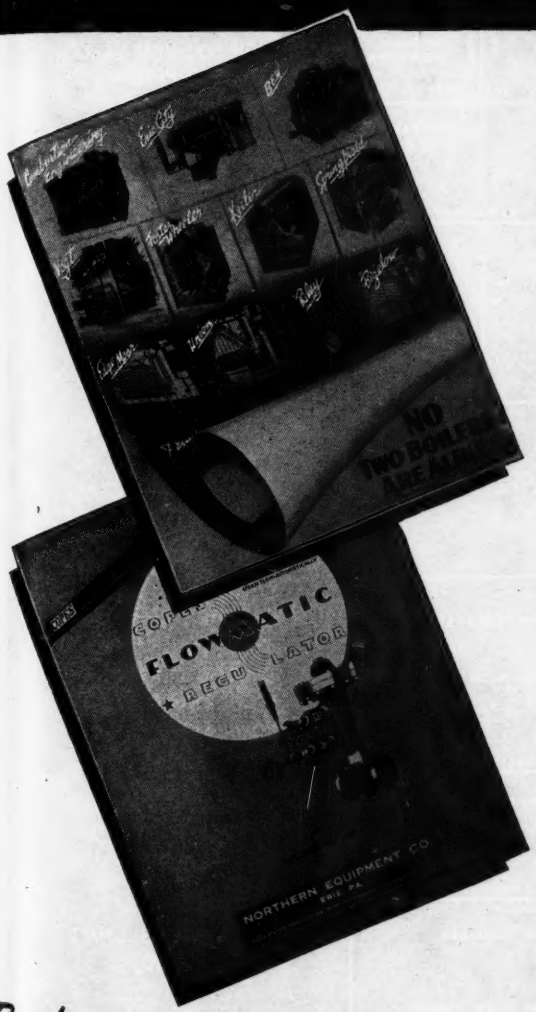

1. Copes Flowmatic varies the rate of feed in proportion to changes in steam flow, with secondary compensation from boiler water level.
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13. Available in both direct operated and relay operated types.
14. Flowmatic is a Copes Product—symbol of pioneering and leadership in feed water regulation.

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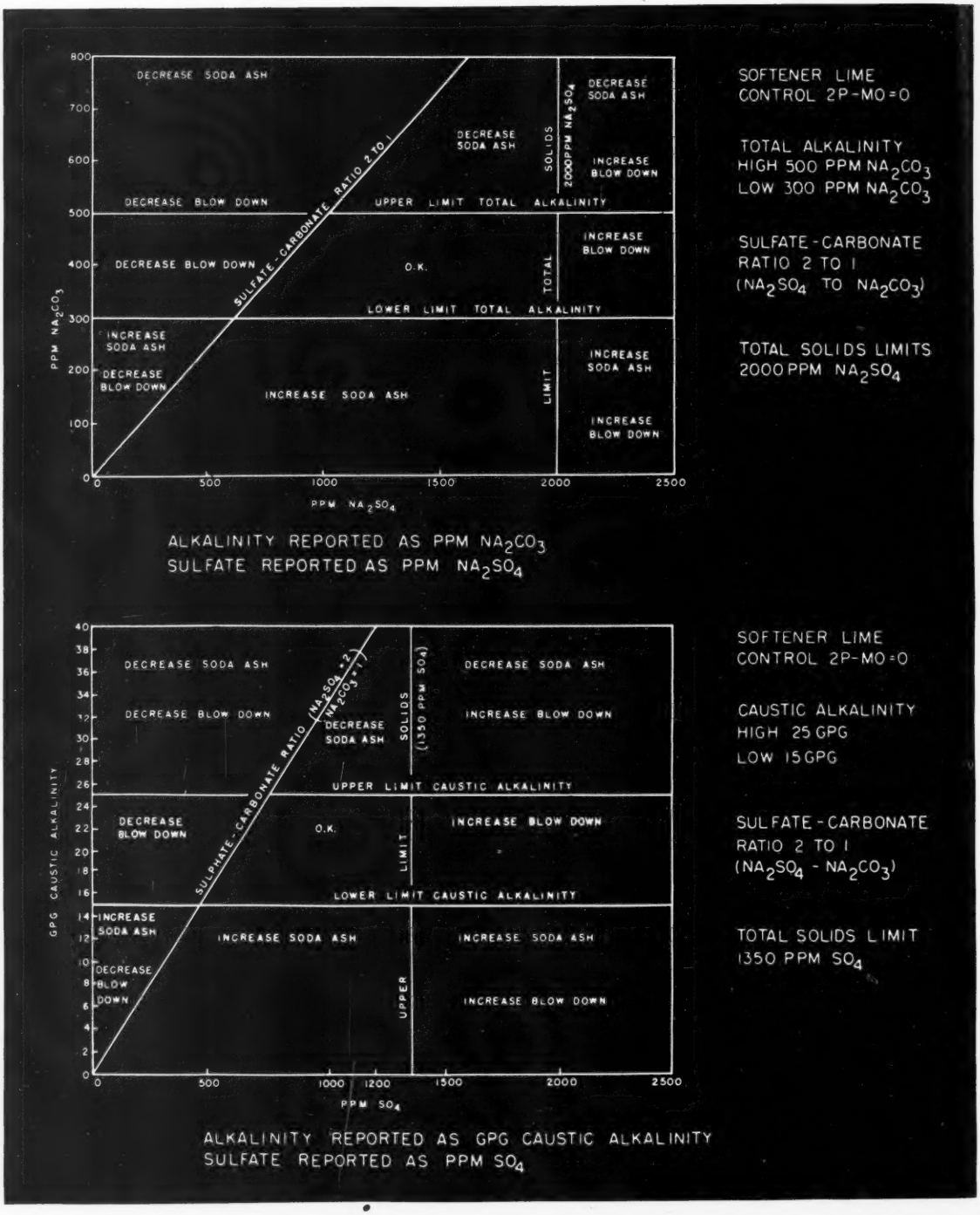
BOILER WATER CONTROL CHARTS

By William J. Wright



These two charts should be useful as visual guides in maintaining proper boiler water control. The upper one is for use where values of sulfates and alkalinities are reported as parts per million of sodium sulfate and sodium carbonate respectively. The lower one is for use where sulfates are reported in parts per million of the sulfate radical and alkalinities as grains per gallon of caustic alkalinity, as is done by some of the better known consultants. Both charts are accurate and they can be arranged to suit almost any set of conditions. For further information of methods of boiler water control see the article by Wm. Wright on page 110 of this issue

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SUN DIESEL LUBRICANTS . . .

stop ring sticking . . . cut operating costs

Heavy carbon . . . gummy deposits . . . stuck rings in a diesel do not add up to efficient operation. And this trouble may often be traced directly to the lubricant.

Breaking rings to free them during the annual overhaul of a six cylinder diesel was the general practice of a large New England contractor. The lubricants he was using formed hard carbon and power-killing gummy deposits. Parts replacement costs ran high and overhauling became an expensive proposition.

Costs dropped after a Sun Oil Engineer suggested a change to a Sun Diesel Lubricant. No excessive carbon deposits were present at the next overhaul. The slight amount that did form was of a soft nature which was easily wiped away. All piston rings were free, including the top rings. Costs of lubrication and replacement parts dropped to a new low.

Engineering "Know How" of Sun Engineers and the proved quality of Sun Lubricants can do much to step up the operating efficiency of your diesels, gas engines, gasoline engines, steam turbines or electric motors. Sun service is yours to use for improved production, lower costs and more efficient operation. Write . . .

SUN OIL COMPANY • *Philadelphia 3, Pa.*

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SUNOCO

SUN INDUSTRIAL PRODUCTS

OILS FOR AMERICAN INDUSTRY

PIT 5

Latest and largest of PG & E's 52 hydroelectric plants, Pit 5 has installed capacity of 160,000 kva in four 40,000-kva units, operating at 587 ft head, 300 rpm, generating at 11.5 kv for transmission at 230 kv. Pilot exciters omitted to gain stability. Self-cooled transformers for lower maintenance. Divided 11.5 kv bus to isolate trouble; paralleling done at 230 kv. Porcelain-insulated copper bars instead of generator cable. Power plant building kept under positive pressure by blower system

By E. F. MARYATT

Assistant Hydroelectric Engineer, Pacific Gas & Electric Co.

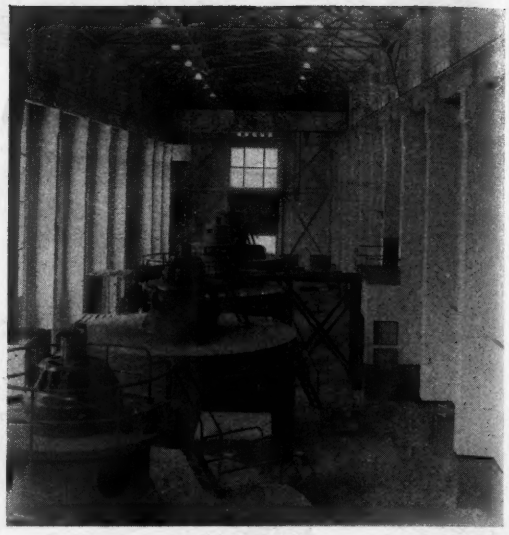


Fig. 1. Four 40,000-kva generating units at Pit 5

IT IS A special event when the opportunity arrives for developing 200,000 hp from a 3300 cfs mountain stream, because native sites for such projects are not common. It is a noteworthy accomplishment for this company because, of the 52 hydroelectric plants it now owns and operates, Pit 5 is the largest by almost two to one. It is the largest hydroelectric plant in operation in the State of California at the time of this writing.

Ten miles of Pit River rapids around the "Big Bend" in the river afford a head of 630 ft static, which is made available by approximately 28,000 ft of tunnel, 3100 ft of open conduit and 1400 ft of penstock. The tunnel is 19 ft in diameter, concrete lined, and in two sections with the open conduit between. At the lower end of the tunnel just above the penstock connections is a differential surge chamber built into the side of the mountain. It will permit reducing the tunnel velocity of approximately 12 fps to zero or increasing it again to 12 fps in 4 min.

Diversion Dam

Diversion of water from the river is handled by a concrete overflow gravity type diversion dam 340 ft wide and equipped with four 50 ft by 26 ft electrically-operated, counterbalanced, wheel-type gates. Room for an overflow type spillway was not available in the length of the dam. The water elevation for diversion purposes is controlled first by manual adjustment of the power house output and second by automatic operation of the gates, which are intended to operate only when it is necessary to waste water.

Penstocks

The lower end of the tunnel diverges into four all-welded steel penstocks 108 in. in diameter reducing to 90 in. at the power house. The upper end of each penstock is equipped with a 120-in. hydraulically-operated butterfly valve, arranged to trip on excessive water velocity. The lower end of each penstock, at the entrance to the turbine, has a 102-in. hydraulically-operated butterfly valve arranged to trip on excessive unit speed. Either valve may be tripped electrically by the operator. They were made hydraulically operated because energy for operation must be available at all times.

Size of Units

Four units of 50,000 hp each proved to be a convenient size for this plant. This size worked out well hydraulically because the specific speed of 23 is well under the limitations for this head. The unit speed of 300 rpm is a convenient design speed for the generator manufacturer and resulted in good proportions of height to diameter for a unit of this type.

Two sections only were required for the generator stator and the water wheel casing to meet shipping and hauling limitations. The current rating of the generators was well within standard oil circuit breaker capacities and a desirable grouping of the units avoided excessive current values in the bus.

Four units of this size gave a convenient size plant for operation, and the even number of units permitted a simple and symmetrical arrangement.

Water Wheels

The wheels are vertical-type Francis turbines, designed for 587 ft effective head and for 825 cfs of water. Predicted maximum efficiency is 92 per cent based on the model runner test. The runner is cast steel, having 13 vanes and a maximum diameter of 109 in. It is bolted to the end of the shaft with tapered bolts, permitting it to be lowered vertically for removal. The seal ring clearances are 0.0020 in., with Parsons white brass wearing rings. The packing gland is on the shaft immediately above the runner. The turbine guide bearing just above the packing gland is oil lubricated, with minimum tolerance to permit the close seal ring clearance necessary at this head.

Runner Removal

A tunnel through the concrete foundation below the turbine casing exposes the upper section of the steel draft tube, which is removable to permit access to, and convenient removal of, the runner. The draft tube is the conventional elbow type and was prefabricated from welded steel plate reinforced to permit its use in the concrete as forms when pouring. The water wheel casings are steel plate all welded construction with the exception of the speed ring section which is cast steel.

Included with each turbine is a Pelton 60-in. balanced pressure relief valve with energy absorber. This device opens with the closing motion of the servo-motors and recloses in 4 to 5 min time. It is governor stalling, to prevent the governor from closing the guide vanes if the relief valve should stick or otherwise fail to open. If the relief valve fails to open, preventing the governor from closing the guide vanes, the turbine shutoff butterfly valve will close, provided the unit overspeeds. The unit is designed for 185 per cent speed but it is never intended that it shall reach that value. Each turbine is equipped with a

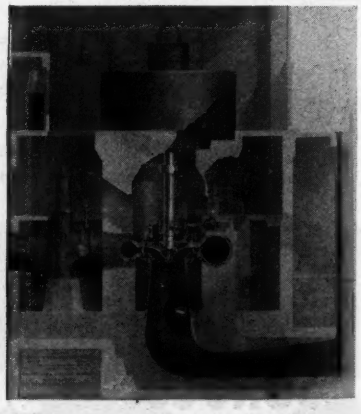
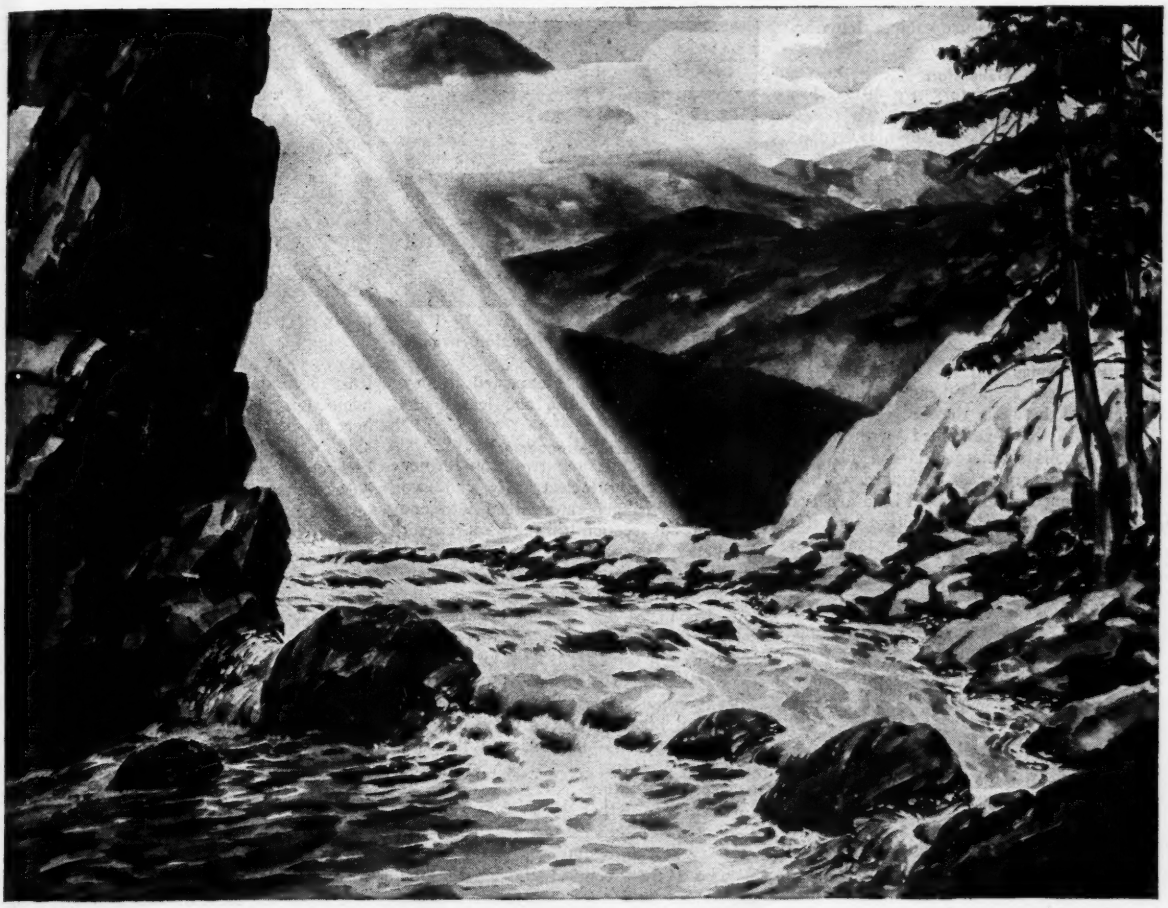


Fig. 2. Cross-section through one of 40,000-kva units



Rough turns slow the flow

CONSIDER how the wild mountain stream twists and turns, uses up energy cutting away at banks and boulders, fighting obstructions that impede its smooth flow. Smooth, efficient flow is assured in piping systems using Tube-Turn welding fittings. Every fitting is checked for inside smoothness.

Maximum efficiency of flow is important to industry. Other advantages of Tube-Turn welding fittings over other fitting types include: Greater strength, less weight, lower maintenance costs. Tube-Turn welding fittings permit greater flexibility of layout, are easier to insulate. Increased safety at points of highest pressure and longer life for the entire system are more reasons for specifying Tube-Turn welding fittings.

For complete information on the superiority of Tube Turns' exclusive manufacturing methods and data on successful installations in many industries, write for Catalog 111. Distributors in all principal cities.

Selected Tube Turns Distributors in every principal city are ready to serve you from complete stocks.

TUBE TURNS (Inc.) Louisville, Kentucky. *Branch Offices:* New York, Chicago, Philadelphia, Pittsburgh, Cleveland, Dayton, Washington, D. C., Houston, San Francisco, Seattle, Los Angeles.

Compare for Smoothness

See how sharp corners and surface irregularities obstruct flow in cast iron threaded elbow. Compare for smoothness with unobstructed flow in smooth Tube-Turn elbow.

TUBE-TURN TRADE MARK *Welding Fittings and Flanges*

Woodward oil-pressure cabinet actuator-type governor.

Generators

The four generators are 40,000 kva each, liberally designed for 0.8 power factor, 11,500 v. The insulation is class B throughout. The short circuit ratio is from 1.3 to 1.5 and amortisseur windings are included. These generators are totally enclosed and air cooled, with surface air coolers receiving water from the tailrace as a cooling medium. Each generator has two self-lubricated guide bearings, one above and one below, and a thrust bearing located above the rotor. Two machines have Kingsbury type thrust bearings and two have the General Electric spring thrust. Oil is not circulated between the bearings. Each bearing is self-contained with water cooling coils submerged in the oil.

Each generator is equipped with a direct-connected exciter. There are two separate motor driven exciters, one for each pair of generators, for standby or emergency use.

No Pilot Exciters

Machines of this type are prone to overspeed upon complete rejection of load. The direct-connected exciter overspeeds with the generator; a direct-connected pilot exciter also overspeeds. This makes it difficult to hold generator voltage down even with the modern voltage regulators. Also 230-kv transmission lines build up voltages excessively if opened under load at the receiving end. To make these conditions more controllable, the pilot exciter was eliminated and the main exciter field is supplied with exciting current from the station control battery and charging sets.

Main Transformers

Power from the four generators is fed through two step-up transformer banks increasing the voltage from 11,500 to 230,000 v for transmission. The two banks consist of six 27,000-kva single phase self-cooled transformers with one spare transformer. Self-cooled transformers were used, where water for cooling is in abundance, to obtain longer life and less maintenance. Cooling coils, no matter how pure the water, have a limited life. Leaks are not always immediately discovered. Handling and filtering oil introduces oxygen, which may cause sludging. The less the oil is handled the better. These transformers were filled under vacuum and have inert gas equipment. The additional cost of self-cooled transformers is expected to pay dividends in longer life and less maintenance.

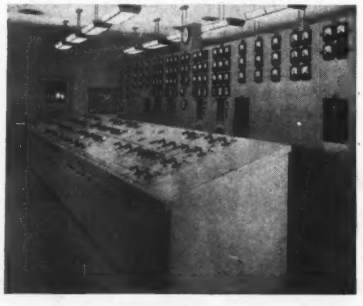


Fig. 3. Control room has fluorescent lighting and separate air conditioning system

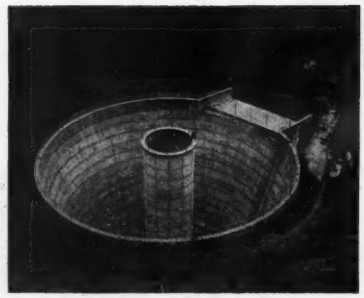


Fig. 4. Top of the differential surge chamber

Electrical Arrangement

The four units and two transformer banks are grouped electrically into two sections. Two generators feed into one 11.5 kv bus section through oil circuit breakers. One transformer bank is fed directly from this bus without an intervening oil circuit breaker and constitutes one section of the station. The other section is identical, with no interconnection between the two at 11.5 kv.

Paralleling is done at 230 kv only. For this purpose, four 230-kv, 5-cycle oil circuit breakers are provided between the two transmission lines and the two transformer banks. Either bank may be connected to either line or both banks connected to either line or both lines connected to either bank.

Generator Cables Eliminated

The 11.5-kv connections between the generators and the transformer banks are copper bars, porcelain insulated, metal enclosed. The entire 11.5-kv installation was factory built to fit the space available, factory assembled and sectionalized for shipment.

The 11.5-kv metal clad bus design includes a minimum number of oil circuit breakers. The main and transfer bus scheme permits the use of only one breaker per circuit with one spare breaker which can be switched in, to replace any of the other breakers.

As previously mentioned, there is no oil circuit breaker in the 11.5-kv side of the main transformer banks. A breaker, if used in this position, would be at least 5000-amp rating, which is to be avoided if possible. It is easily avoided here by protecting the bank from this side with both generator oil circuit breakers. Since the generators have no outlet if the bank is in trouble, there is no point in keeping them on the bus. The disconnecting switches are mechanically gang operated and completely interlocked.

Fig. 5. Oil circuit breakers and portion of bus structure

To provide station service power in a manner that it will always be available, if either section of the station is out, duplicate station service transformers are provided, one being fed from each section. These banks have a rating of 1500 kva each and reduce the voltage from 11.5 kv to 440 v. Each bank has sufficient capacity to supply the entire auxiliary power requirements. The 440-v station power feeders may be switched to either bank, however, the normal operating procedure will be to feed the auxiliaries of each section of the station from the bank on that section.

To provide quick and convenient transfer from one bank to the other, metal-clad 440-v double bus cubicles were purchased. Each 440-v circuit is equipped with two electrically-operated circuit breakers, electrically and mechanically interlocked, with the controls connected to provide a quick double throw.

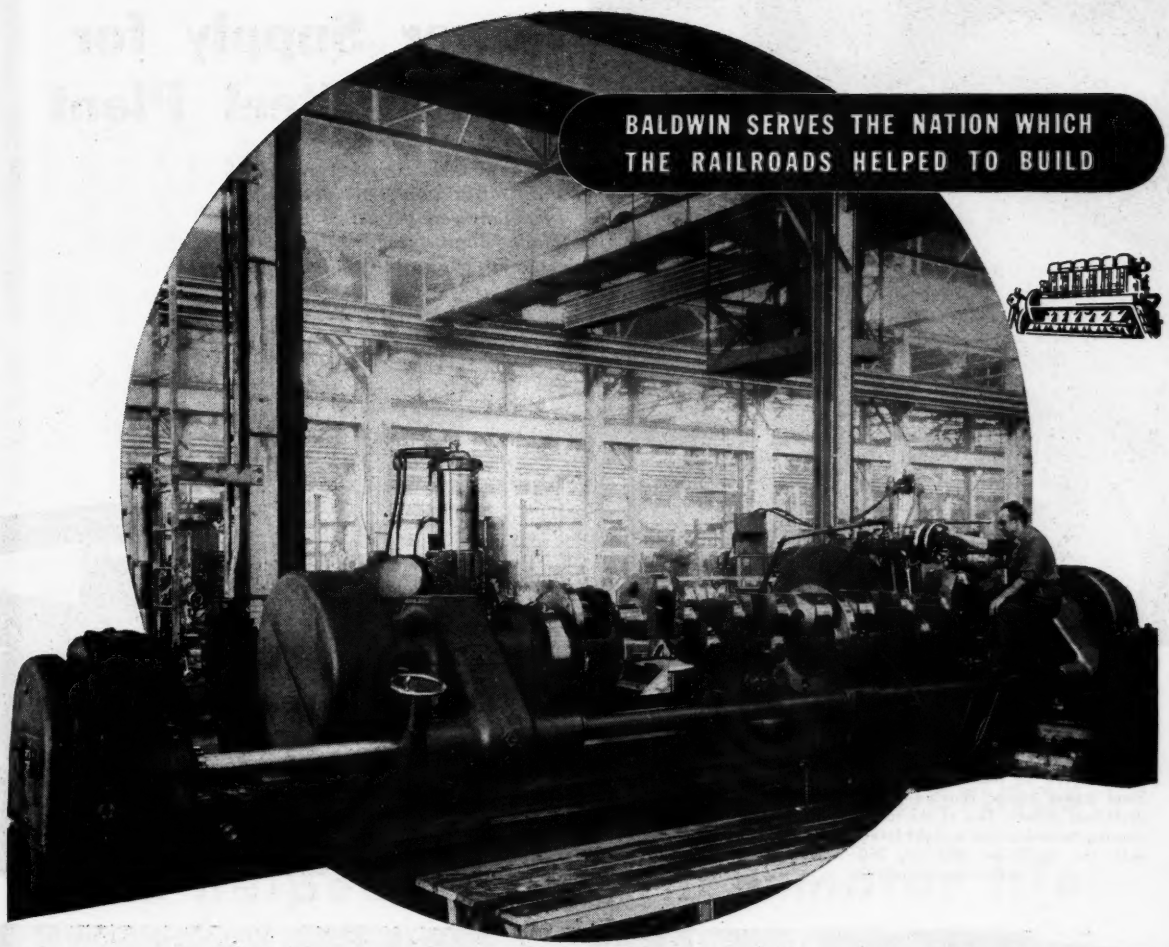
All auxiliary transformers in the station are dry type air cooled. There is no insulating oil in the station except the small amount in the "H Type" oil circuit breakers.

There are two duplicate station control batteries, each sufficient to supply the

(*Continued on Page* 128)

Principal Equipment, Pit No. 5, Hydroelectric Plant

Generators: 2—40,000 kva, surface cooled, 0.8 P.F., 11,500 v.....General Electric Co.
Generators: 2—40,000 kva, surface cooled, 0.8 P.F., 11,500 v..Westinghouse Electric & Mfg. Co.
Transformers: 7—27,000 kva, self cooled, 1 phase 11.5/240 kv with taps.....Westinghouse Electric & Mfg. Co.
Transformers, Sta. Service: 6—500 kva, 1 phase dry type, 11,500/440 v.....Westinghouse Electric & Mfg. Co.
Reactors: 3—12,500 kva, self cooled, 11,500 v 3 phase.....General Electric Co.
Turbines, Francis: 4—50,000 hp, 300 rpm, 630 ft head static.....Pelton Waterwheel Co.
Turbine Casings, fabricated and welded by Allis-Chalmers Mfg. Co.
Butterfly Valves: 4—102 in., 630 ft head, hydraulically operated...Joshua Hendy Iron Works
Butterfly Valves: 4—120 in., 110 ft head static, hydraulically operated.Pelton Waterwheel Co.
Relief Valves, with energy absorber: 4—5 ft diam, 630 ft head, 950 cfs.Pelton Waterwheel Co.
Lightning Arresters: 6—220 kv, 1 phase, Thyrite, 16 units per pole.....General Electric Co.
Oil Circuit Breakers: 4—Ty. FHKO-339 230 kv, 3 phase, 5 cycle, pneumatic operators.....General Electric Co.
Oil Circuit Breakers: 10—11.5 kv Metal clad, Type FH 126, 1,000,000 kva..General Electric Co.
Air Break Switches: 10—230 kv, 3 phase, type P & Ty. TS, 1200 amp.....Pacific Electric & Mfg. Co.
Storage Batteries: 2—60 cell, FM-11 Exide.....Electric Storage Battery Co.
Charging Sets: 3—15 kw, 140 v, diverter pole.....Electric Products Co.
Cranes: 2—100 ton, 15 ton aux., span 50 ft.....Judson
Governors: 4—Oil Pressure Cabinet type...Woodward Governor Co. (Pelton Waterwheel Co.)
Gates, Diversion Dam: 4—Wheel type 50 ft x 26 ft 7 in. counterbalanced..Moore Dry Dock Co.
Gate Intake: 1—Wheel type, 15 ft x 19 ft.....Pelton Waterwheel Co.
Emergency Power Unit: 1—Gasoline-Engine driven generator, 50 kva.....King Knight Co.
Switchboard, Main: 14 Panels, Bench and Vertical Front and Rear.....General Electric Co.
Switchboard, d-c: 5 Panels, vertical.....Westinghouse Electric & Mfg. Co.
Station Service Bus: Cubicles, double bus, metal clad.....I.T.E. Circuit Breaker Co.



This Crankshaft Grinder

Means Better Diesel Performance for You

BALDWIN
PRODUCTS

Hydraulic presses, Testing equipment, Steel forgings and castings, Diesel-electric locomotives, Diesel engines, Metal plate fabrication, Rolled steel rings, Bronze castings, Heavy machine work, Crane wheels, Bending rolls, Plate planers, Babbitt metal, Alloy iron castings. Briquetting presses.

BALDWIN
DIESEL ENGINES

Here is one of the reasons why your Baldwin Diesel engine will give you something more in economy, service and all-round satisfaction.

It is one of the world's largest crankshaft grinders, recently installed to finish an essential part of the engine to within one ten-thousandth of an inch—plus or minus—of designed dimensions, and, at the same time, insure accurate parallelism.

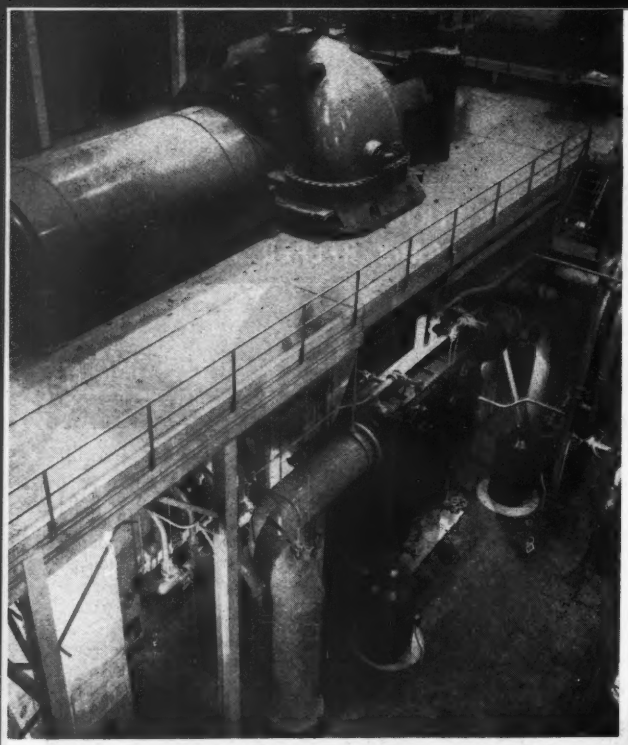
A trip through the Baldwin shop would show you many examples of this emphasis on ultimate quality and accuracy—skilled craftsmen who know how to do a *plus* job . . . and machines that help them to do it.

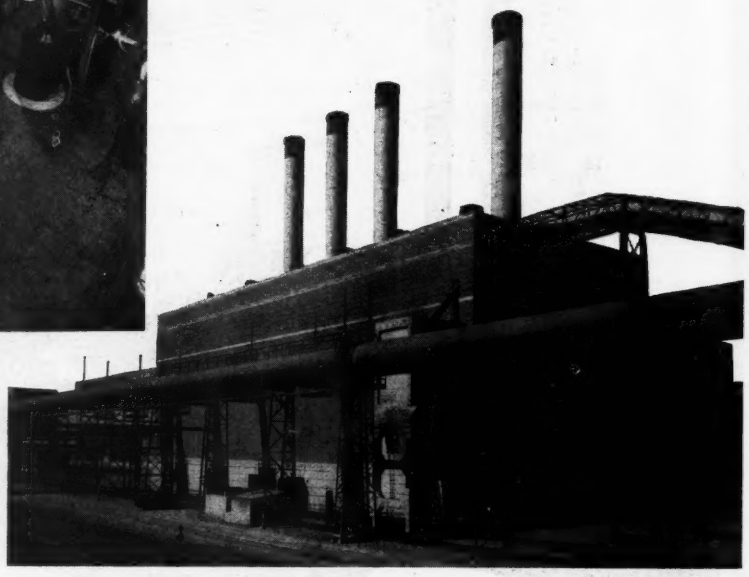
This means extra work and expense . . . but when you purchase your next Baldwin Diesel, you'll recognize the fact that it also means better Diesel performance for you.

The Baldwin Locomotive Works, Locomotive & Ordnance Division, Philadelphia, Pa., U. S. A. Offices: Philadelphia, New York, Chicago, Washington, Boston, Cleveland, St. Louis, San Francisco, Houston.

Power Supply for Geneva Steel Plant

These pictures were not available until after complete details of this plant were published in Power Plant Engineering, July, 1944, page 70; August, 1944, page 80.

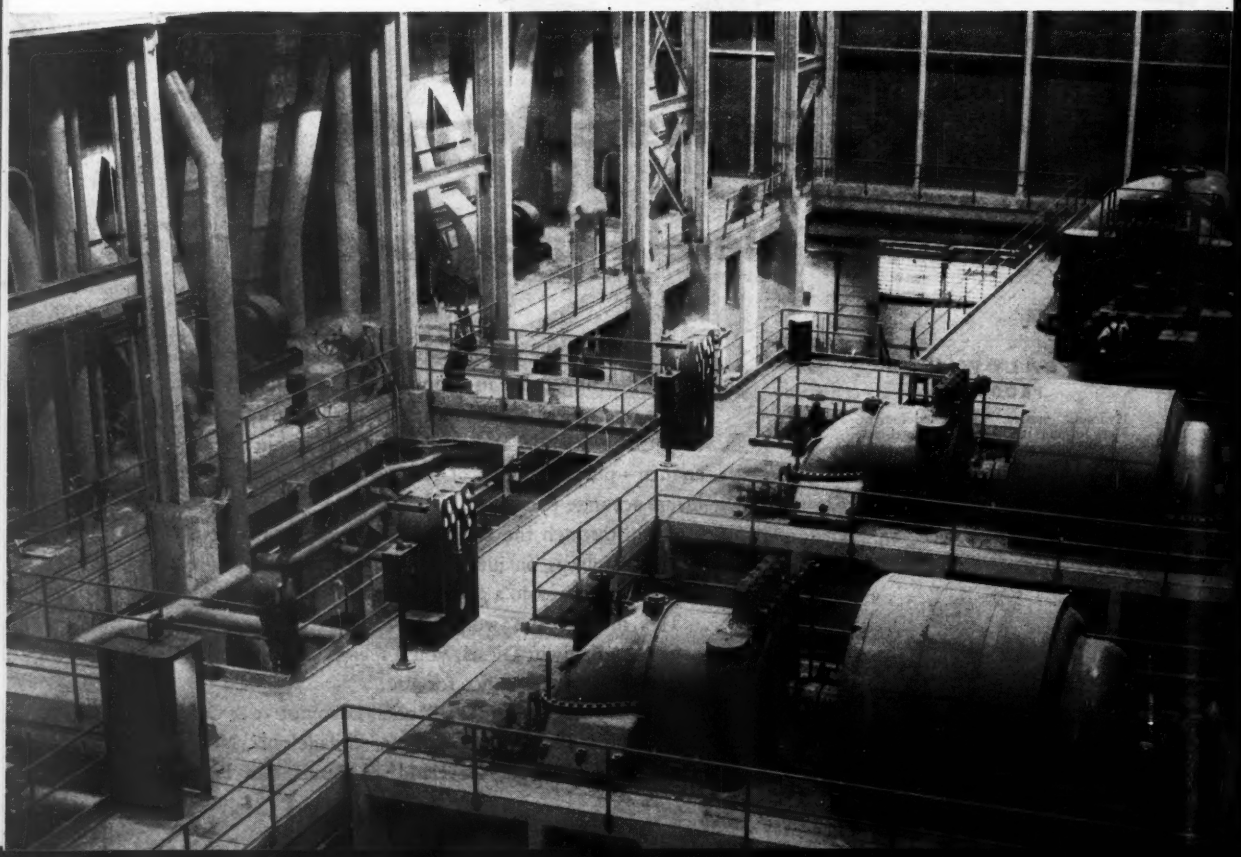




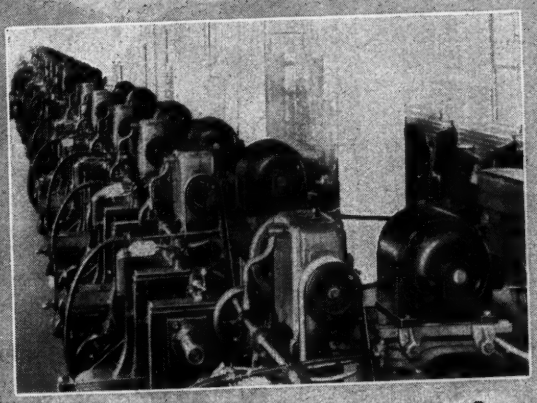
Above: Close-up view of the 50,000-kw turbine-generator unit, with condenser and auxiliaries below

Right: Exterior view of new power house for Geneva Steel Works

Below: View on main operating floor of Geneva Steel power house, showing boilers and induced draft fans at left. Two of the four 95,000 cfm condensing turbo-blowers in right foreground. At right rear, the 50,000-kw, 450 psi, 750 F condensing turbine-generator unit



BEARINGS BEAR UP



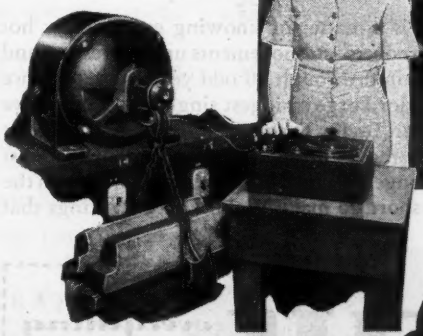
Powered by Tri-Clad sleeve-bearing motors, this battery of milling machines has been in round-the-clock operation on war work since before Pearl Harbor. The short-center, hinge-base drives put a hard, steady pull on the motor bearings. In addition, the machines are in the hands of several different operators each day, many newly trained. Despite the severe service, motor-bearing performance has been above prewar levels. Maintenance manpower has been conserved, and production held on schedule.

Tri-Clad motors driving milling machines in the River Plant Division of the Savage Arms Corp., Chicopee Falls, Massachusetts.

How torture tests on TRI/CLAD bearings have helped us lengthen motor life

Before the Tri-Clad motor-bearing designs were adopted, many models of this new motor were tested to destruction under heavy shaft loadings applied from all directions, with various kinds of lubricants, and under many different speed and temperature conditions. As new Tri-Clad types are introduced, these tests continue—some for years—in "torture" areas such as shown at right. Each test broadens our knowledge, offers new clues to longer motor life. Throughout industry, results have substantiated the improved bearing performance forecast by these tests.

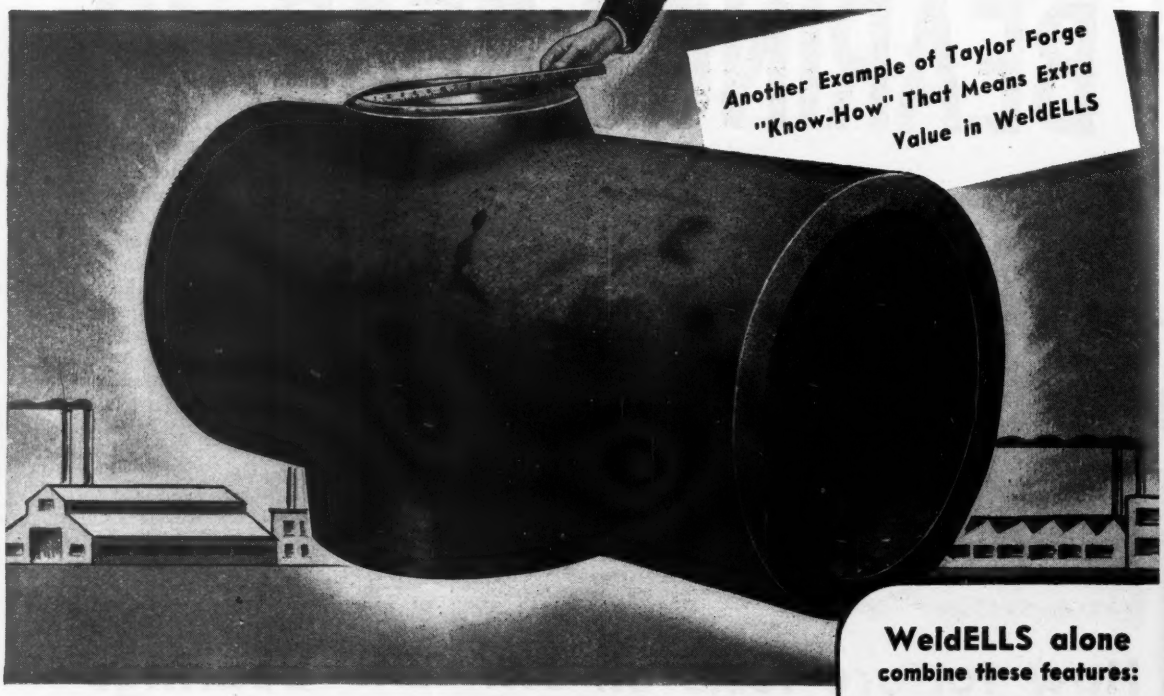
General Electric Company, Schenectady 5, New York.



GENERAL ELECTRIC

Buy all the **BONDS** *you can* — **AND KEEP ALL YOU BUY**

A CROSS WITH A MESSAGE



★ *When the big crosses originally furnished on an important oil refinery job began to show signs of failure the contractors (one of the biggest and best firms of refinery engineers and contractors in America, by the way) decided to replace them with wrought and forged fabricated units.*

Like so many other difficult and exacting jobs this one was turned over to Taylor Forge, and the cross pictured above is one of a number made of seamless carbon moly tubing furnished by the contractor. The outlets are integrally formed to close tolerances. The run ends will be beveled like the outlets and Taylor Forge Flanges welded to both ends of the run and to the outlets. Perhaps in a later issue of this magazine we can show you the complete unit.

HANDLING jobs like this is a matter of knowing exactly how hot metal behaves and how to control its movements under pressure and impact. That knowledge, acquired through 40 odd years of experience and continuous research, is Taylor Forge's biggest single asset. It enables us to make WeldELLS and other Taylor Forge Welding Fittings exactly what they should be—to place the right amount of reinforcement just where it is needed, to provide tangents which keep the weld away from the most highly stressed zone. In short, to make WeldELLS the fittings that *"have everything"*.

WeldELLS alone combine these features:

- **Seamless** — greater strength and uniformity.
- **Tangents**—keep weld away from zone of highest stress—simplify lining up.
- **Precision quarter-marked ends**—simplify layout and help insure accuracy.
- **Selective reinforcement** — provides uniform strength.
- **Permanent and complete identification marking**—saves time and eliminates errors in shop and field.
- **Wall thickness never less than specification minimum**—assures full strength and long life.
- **Machine tool beveled ends**—provides best welding surface and accurate bevel and land.
- **The most complete line of Welding Fittings and Forged Steel Flanges in the World** — insures complete service and undivided responsibility.

WeldELLS have everything

TAYLOR FORGE & PIPE WORKS, General Offices & Works: Chicago, P.O. Box 485
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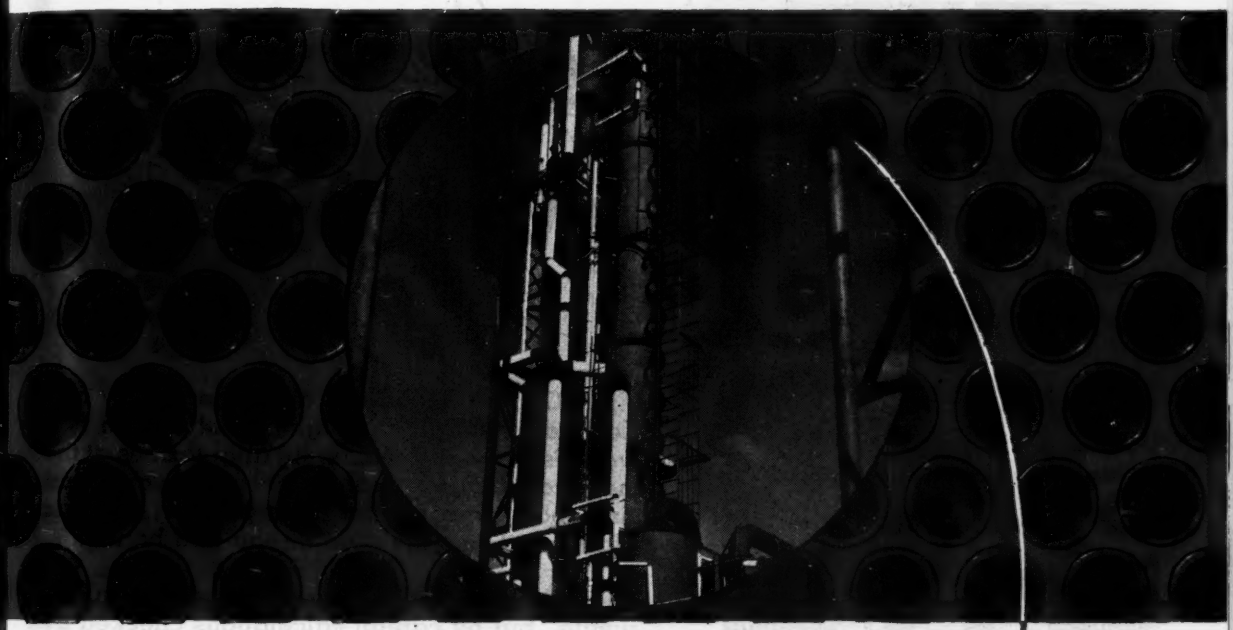
DOWELL

CHEMICAL SCALE REMOVAL SERVICE



RESTORES OPERATING EFFICIENCY

Dowell Chemical Scale Removal Service is widely used in the Refining Industry because it restores heat transfer efficiency and reduces operating costs.

Safe, economical, rapid—Dowell Chemical Scale Removal Service requires no extensive dismantling of equipment and reduces down-time to a minimum.

Thorough knowledge of the composition of the scale deposit, metals and working temperatures dictates the selection of the proper inhibited solvent, addition agents and treating techniques—all necessary to complete removal of the deposit.

Mobile equipment and trained engineers are available at many strategic points. Call the nearest Dowell office for information and service.

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Tulsa 3, Oklahoma

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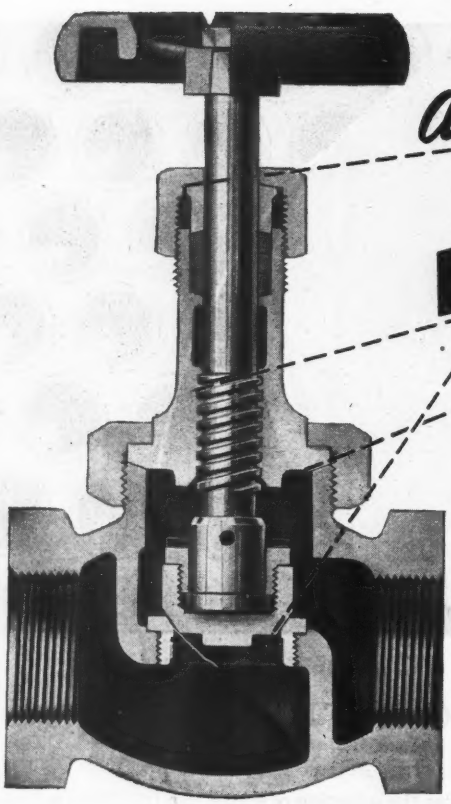
"Trifles make perfection but perfection is no trifle"

One of a series of advertisements explaining how Kennedy gives careful attention to the details of valve design, construction and workmanship that provide maximum effectiveness, convenience, and length of service.

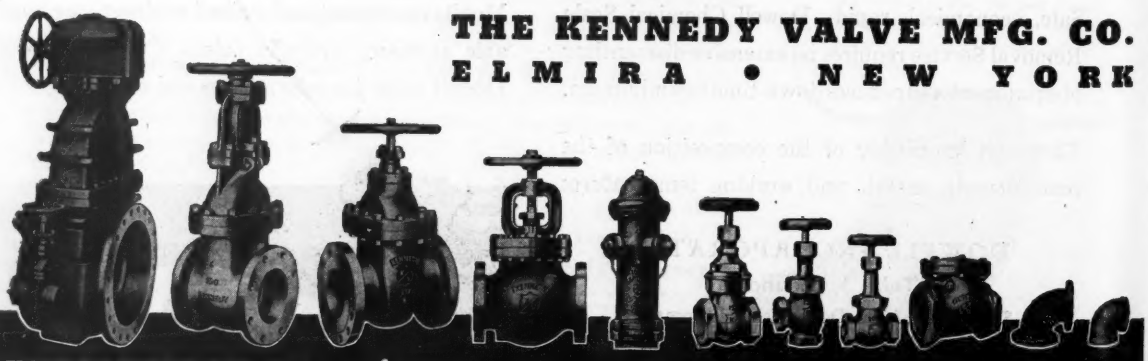
Why are all these ANGLES DIFFERENT



YOU are looking at a sectional view of a Kennedy 200-lb. bronze globe valve with full-way disc. Notice the different angularities at the metal-to-metal contacts between disc and seat ring, body and bonnet joint, packing nut and gland, and also the stem thread and bonnet.

These angles were not determined by "guesstimate" but by careful calculations checked by lengthy tests and actual service experience. It would have been easier to have made most of them uniform, but Kennedy doesn't do things that way. Each of these angles helps to give you, for its particular requirements, the tightness, plus convenience, plus long wear that provide extra values in all Kennedy Valves, and have impelled so many plants to standardize on them for over 60 years.

THE KENNEDY VALVE MFG. CO.
ELMIRA • NEW YORK



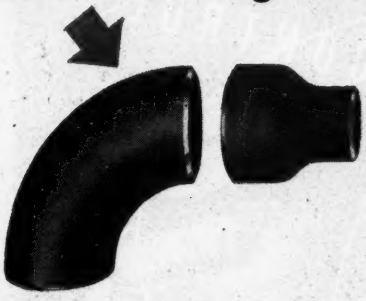
KENNEDY *valves... pipe fittings... fire hydrants*

THIS

IS BETTER

PIPING PRACTICE

Than these Together



Why make three welds when two will produce a better piping job? Where it is necessary to change both the direction of flow and size of pipe, the Midwest Reducing Elbow replaces two welding fittings: (1) a standard elbow and (2) a reducer. The many important features are enumerated at the right.

All the advantages of Midwest Standard Elbows are to be found in Midwest Reducing Elbows: unusual dimensional accuracy and uniformity, beneficial effect of working metal in compression, stress relieving, etc. Center-to-end dimensions are the same as in standard elbows with which they are interchangeable.

The Reducing Elbow is only one of the many Midwest developments designed to improve the quality of welded piping and to save cost in erection. Write for Bulletin WF-41 for complete information about the advantages of Midwest Welding Fittings.

MIDWEST

REDUCING WELDING ELBOW

Eliminates One Weld

Cuts Installation Costs

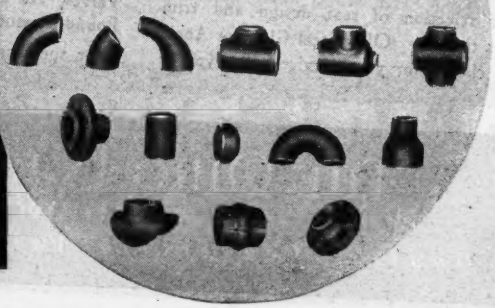
Saves Time

Reduces Turbulence

Improves Appearance

MIDWEST

WELDING FITTINGS IMPROVE DESIGN AND REDUCE PIPING COSTS



MIDWEST

PIPING & SUPPLY COMPANY, INC.

Main Office: 1450 South Second St., St. Louis 4, Mo.

Sales Offices: New York 7—(Eastern Division) 30 Church St., Chicago 3—645 Marquette Bldg. • Los Angeles 33—520 Anderson St. • Houston 2—229 Shell Bldg. • Tulsa 3—533 Mayo Bldg. • Atlanta 3—Red Rock Bldg. • South Boston 27—426 First St. • Distributors in Many Cities

ACCURATE and positive control of fluid flow over a broad range of throttling and full-flow services is assured with OIC Cast Steel Globe and Angle Valves.

Spherical Type discs and seat rings for full-area open-and-closed service . . . Plug Type for throttling and high-velocity flow. *Both* designs are available in a number of trims, adapted to the control of steam, water, oil or oil vapor at temperatures up to 1000°F. Proper selection of seat design and trim assures that the OIC Steel Globe or Angle Valve chosen for your service will give the maximum in performance and trouble-free operating life.

In addition to an unusual flexibility of application, these valves offer the regular OIC construction features . . . unobstructed waterways . . . strong, safe bonnet joints with through bolt-studs . . . durable, smooth-operating stem threads . . . convenient, time-saving repacking feature.

OIC Cast Steel Globe and Angle Valves, and their companion Gate and Swing Check Valves, are available in the 150 and 300-Pound pressure classes.

Trim specifications available on request.

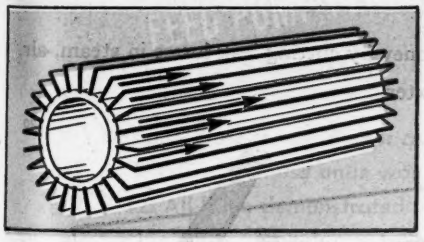
There is an OIC Distributor near you, ready to demonstrate to you the many superior features of OIC Cast Steel Valves. Call him . . . or write to us for details.

OIC

THE OHIO INJECTOR COMPANY
WADSWORTH, OHIO
Quality Leaders in Valve Manufacture Since 1883

THE G-FIN STORAGE TANK OIL HEATER
These units can be furnished for installation either inside or outside of the storage tank.

Why Heavy Oil Flows Freely From These Storage Tanks



LEAST PRESSURE DROP . . . because the liquid to be heated passes without change in direction along the straight channels provided by the longitudinal G-FINS of the heating elements, with maximum free area for flow of oil through the heater. This is one of the 10 major superiorities of the G-Fin Storage Tank Oil Heater described in Bulletin 1641 which will be sent on request.

No matter how cold the weather, nor how viscous the oil, a G-FIN Storage Tank Oil Heater assures *speedy* flow of oil, because of the effectiveness of its G-Fin elements, which have 5 times the heat transfer surface of a plain tube or pipe occupying the same cross-sectional area.

Moreover, the flow of oil is dependably *continuous*, because the design of this heater prevents vapor binding or stratification of the hot oil or vapor.

Many thousands of G-Fin Storage Tank Oil Heaters are in use at storage tanks, service tanks, loading wharves or platforms, chemical plants, gas plants . . . wherever fuel oil, lubricating oil, crude oil, tar, asphalt, road oil, cottonseed oil, molasses; or other viscous liquids are stored . . . and their rapidly increasing use demonstrates their uniformly successful service.

THE GRISCOM-RUSSELL CO.

285 MADISON AVENUE, NEW YORK 17, N. Y.

GRISCOM-RUSSELL

Pioneers in Heat Transfer Apparatus

..AS SALES MANAGER I'M INTERESTED IN BETTER VALVE MAINTENANCE

. . *It means surer, quicker deliveries!*

I don't know much about valves — but I do know that when they leak, and must be repaired or replaced, things happen to production, and my deliveries go to pot!

Since our canny engineers ordered that Dexter Valve Reseating outfit we haven't had a single shutdown due to valve leaks. And, I understand that one man operating the Dexter can *reseat* a valve, *right on the line,* in a few minutes. It used to take a crew several hours — if they could repair the valve.

They tell me we're saving big money by cutting leak losses in steam, air, water and oil, too . . . thanks to Dexter.

20

Drop us a line . . .

giving your toughest valve-leak story . . . make, type, size and material . . . whether water, air or steam. We'll show you how to answer your problem with Dexter equipment.

A large part of our production facilities is devoted to war work. Orders for Dexter Machines and Cutters, from firms who want this economy and efficiency, have far exceeded our non-military manufacturing facilities. Please be patient — we will deliver just as quickly as possible.

DEXTER VALVE RESEATING MACHINES AND CUTTERS for Globe, Gate and Pump Valves

THE LEAVITT MACHINE COMPANY
ORANGE, MASSACHUSETTS

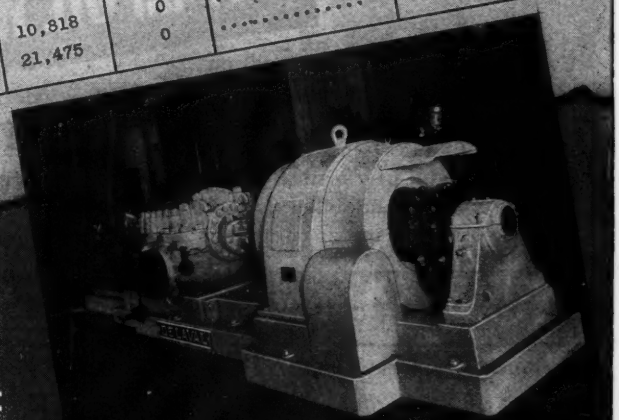
Look at the Record!

SERVICE RECORD—As of September 1, 1944

DE LAVAL PUMPS at _____

No.	Discharge Pressure psig	Suction Temp. °F.	Placed in Service	Total Service Hours	Outages Due to Pump	Cause of Outages	Approx. % Increase in Pump Power
14	1186	260°	12- 2-38	40,383	2	Replace ball locating bearing and shaft sleeves	Negligible
15	1186	260°	10-11-40	28,839	1	Replace shaft sleeves	Negligible
21	1186	350°	8- 4-39	10,818	0	.....	Negligible
16	1186	260°	1- 2-42	21,475	0	.....	5%

Capacity (all units).....1455 g.p.m.



of DE LAVAL HIGH-PRESSURE BOILER-FEED PUMP PERFORMANCE

Not one major trouble after as much as 40,000 hours of service!

The first of these units was installed in February, 1938; the most recent in February, 1942. All have demonstrated the satisfactory performance of De Laval boiler-feed pumps for high-pressure central station service.

Other important installations, operating at pressures up to 1600 psi and handling high temperature feed water, are operating with equal freedom from trouble, due in no small measure to the excellent performance of the De Laval automatic balancing device, the De Laval large clearance labyrinth wearing rings, and the sturdiness of De Laval solid end head construction.

3629

TURBINES • HELICAL GEARS • WORM GEAR SPEED REDUCERS • CENTRIFUGAL PUMPS • CENTRIFUGAL BLOWERS and COMPRESSORS • IMO OIL PUMPS

DE LAVAL

STEAM TURBINE COMPANY · TRENTON 2, NEW JERSEY

SALES OFFICES: ATLANTA • BOSTON • CHARLOTTE • CHICAGO • CLEVELAND • DENVER DETROIT • DULUTH • EDMONTON • GREAT FALLS • HAVANA • HELENA • HOUSTON KANSAS CITY • LOS ANGELES • MONTREAL NEW ORLEANS • NEW YORK • PHILADELPHIA PITTSBURGH • ROCHESTER • ST. PAUL • SALT LAKE CITY • SAN FRANCISCO • SEATTLE TORONTO • TULSA • VANCOUVER • WASHINGTON, D. C. • WINNIPEG

"Saturday Night" Cleanup for an OIL WELL

Yes, even oil wells need an occasional cleaning to keep up the high rate of production of crude oil needed for our all-out war effort. And to do that job, a large midwestern manufacturer developed a new method of oil well cleaning. With accuracy and dependability as prerequisites for a certain flow measuring job in this connection the manufacturer chose a

HENSZEY FLOW INDICATOR

on a trial basis.

After three months of satisfactory performance four more Henszey Flow Indicators were ordered. Two more repeat orders were sent in to bring the total up to 61 Indicators within a year.

If you need to know the rate of flow—instantly and accurately—choose Henszey Flow Indicators. Send for bulletin FI-1 for details.

- Indicates flow from 0 to 100%
- Graduations uniformly spaced
- Reads direct — without constants
- Only 3 moving parts
- Installed right in pipe line

HENSZEY COMPANY
Dept. C2, Watertown, Wis.

HENSZEY

FLOW INDICATORS

Continuous Blowdown • Distillation Systems • Heat Exchangers
Feed Water Meters • Boiler Feed Regulators • Proportioning Valves

Pit 5

(*Continued from page* 116)

entire station. Three "diverter pole" charging sets provide one for each battery and a spare.

To reduce sweeping, cleaning and wiping, the building was made as air tight as practicable, especially around windows and doors, and ventilating air is admitted to the station through a self-cleaning filter. A 45,000 cfm blower draws air through the filter and distributes it throughout the building. Exit louvres limit the air leaving the station, to create and maintain a positive pressure inside the building, thus preventing the infiltration of dust. Heat exchangers permit a small degree of heating or cooling the air.

Automatic and manual type synchronizing equipment is provided. Carrier current telephone equipment is provided in addition to the metallic circuits. The plant was placed in operation April 29, 1944, without incident and now supplies 150,000 kw to the system.

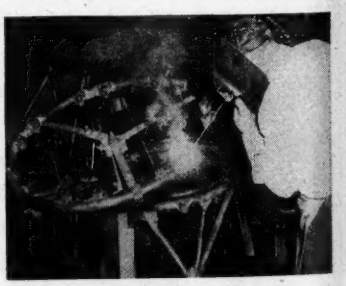
NEW EQUIPMENT

Information that you desire about any equipment will be gladly furnished without obligation. Write to POWER PLANT ENGINEERING 53 W. Jackson Blvd., Chicago 4, Ill.

High Tensile Electrode

FOR FABRICATING aircraft steels, a new high tensile arc welding electrode has been announced by General Electric Co. Capable of making a deposit of high tensile strength comparable to the mechanical properties of the parent metal, the new electrode, known as Type W-55, is especially designed for use in the manufacture of heavy bombers and transport planes.

It can be used for welding in any position, including vertical welding from the top down and from the bottom up. The arc can be struck at the top of the joint and maintained while welding vertically downward, then overhead, then vertically upward back to the starting point.



Arcing characteristics of the W-55 electrode provide flexibility over a reasonably wide voltage range with stable operation throughout. The arc has sufficient force to keep slag from crowding the electrode when welding vertically downward, and the metal sets up quickly when welding overhead and vertically upward.

Characterized by its grey extruded coating, the W-55 electrode is recommended for operation on direct-current straight polarity or alternating current.

LADISH

Assures UNIFORM WELDABILITY

Consistently UNIFORM WELDABILITY of Ladish fittings is assured because they are produced under exacting metallurgical control.

Every Ladish fitting bears the symbol of Controlled Quality . . . the Ladish Heat Code.

ARMY E NAVY

FITTINGS DIVISION

TO MARK PROGRESS

LADISH DROP FORGE CO.

CUDAHY • WISCONSIN

MILWAUKEE SUBURB

District Offices: Lincoln Bldg., New York City • Rockefeller Bldg., Cleveland • Peoples Gas Bldg., Pittsburgh • Sterling Bldg., Houston • Petroleum Bldg., Los Angeles

THE LEVEL-TROL

FLOAT CAGE UP TO 120"

Fisher Level-Trols provide extremely sensitive and dependable liquid level control in all types of vessels, reboilers, side strippers, accumulators, hot wells and other similar installations. They are suitable for handling liquids of all specific gravities.

Level-Trols offer distinct advantages over conventional ball float type liquid level controllers.

1. EXTREMELY WIDE RANGE OF CONTROL . . . Column type float principle of operation makes possible a range of control from ½" to 120". Displacement type float moves only a relatively small distance in proportion to level change.

2. IMPROVED SENSITIVITY . . . Elimination of stuffing box, bearings and other points of friction results in extreme sensitivity of control. Also assures dependable trouble-free service.

3. SPEED OF RESPONSE . . . Intermittent bleed pneumatic type pilot relay speeds the response of the diaphragm valve to level change — guarantees constant level maintenance at all times.

4. FLEXIBILITY . . . Throttling range adjustment makes the Level-Trol suitable for wide variety of applications. Amount of level change necessary to stroke diaphragm valve may be varied from ½" to full length of the float. Pilots may be direct or reverse acting — easily changed over in the field. Wide range of float lengths. Float cages, with screwed or flanged connections, available for all pressure conditions.

Fully illustrated Bulletin F-1 gives full particulars on operation, construction and specifications. Copies gladly furnished without obligation.

FISHER GOVERNOR COMPANY

1024 Fisher Bldg. • MARSHALLTOWN, IOWA

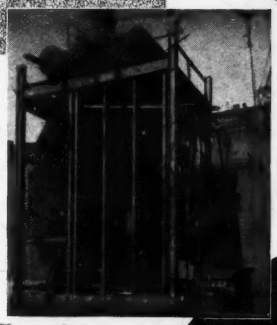
Vogt

PRODUCTS ARE

★ DESIGNED to RAISE
★ OPERATING STANDARDS and
★ LOWER YOUR COSTS

Drop Forged for Safety and Economy under the Most Trying Conditions

Valves, Fittings and Flanges by Vogt—the choice of operating men everywhere for safe and sure regulation of the high pressure and high temperature liquids and gases used in modern process work.



High Operating Efficiencies and Low Maintenance Costs

More steam per dollar of investment—because Vogt steam generating equipment is designed and built to fit in with specific operating conditions. Vogt boilers are available in bent tube types and straight tube, forged steel sectional header types for solid, liquid, or gaseous fuels, as desired. Three-drum types can be supplied to fit any conditions of restricted installation space.

Meeting the Demands for Operating Security

Vogt has every facility for the fabrication of stills, towers, continuous rotary filters, filter presses, oil chilling machines, heat exchangers, etc., and these products are serving the petroleum industry around the world.

Vogt

PRODUCTS

For Oil Refineries, Chemical Plants, Power Plants and Related Industries

☆

HENRY VOGT MACHINE CO.

LOUISVILLE, KENTUCKY

NEW YORK • PHILADELPHIA • CLEVELAND • CHICAGO • DALLAS

To Combat Corrosion and Product Contamination

Process equipment made from special metals and alloys for the exacting service of the chemical plant is fabricated in our modern shops for many of the well known chemical companies.

Steps Tonnage Up and Costs Down

Our experience of more than 50 years in building profit-making ice and refrigerating machinery is at your command. We make complete units for ice and cold storage plants, packing plants, dairies, breweries, chemical plants, oil refineries, etc.

We Didn't Want to Make Strainers

BUT we needed them for use with Yarway Steam Equipment and couldn't find any to suit us.

So we designed the *YARWAY Strainer.*

Apparently a lot of other people were having "Strainer trouble" because, without a line of advertising, the Yarway Strainers *purchased* in a few years now number *many thousands.*

Why don't you look into this better Strainer for your money? Buy one from your supply house (over 100 Mill Supply Houses now have them).

See its protection against corrosion—*cadmium plating inside and out.*

Examine its *high grade Monel woven wire screen* that stops dirt—lets condensate or other fluids flow freely.

Notice the removeable blow-off bushing. Screen and bushing come out together—go back together, *automatically aligning.*

Six standard sizes from ½" to 2" for pressures to 600 lb.

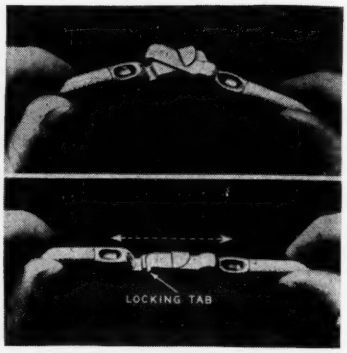
See your Mill Supply House or write for Bulletin S-200

YARNALL-WARING COMPANY
114 Mermaid Ave. PHILADELPHIA 18, PA.

YARWAY STRAINERS

Self-Locking Quick-Disconnect

A NEW self-locking quick-disconnect type of electrical connector, known as the Burndy Clasp, designed especially for small wires, is now available from Burndy Engineering Co., Inc., 107 Bruckner Blvd., New York 54, N. Y. Composed of two identical halves, this new quick-disconnect slides together in jack-



knife fashion and locks in a positive position with a slight pull. This locking feature prevents loosening or pulling-apart in service, even though someone should inadvertently pull or jerk on the cables.

Refractory Gun

DESIGNED to speed up the sealing and insulating of refractory walls, a new gun has been introduced by the Illinois Clay Products Co., 608 S. Dearborn St., Chicago 5, Ill. This gun syphons dry Therm-O-Flake insulation direct from

the shipping carton, mixes with water and sprays to the refractory wall in one operation. Premixing is eliminated. Application is 6 to 8 times faster than by manual methods. It operates on standard air and water pressures, weighs but 4 lb and can be moved about as easily as a man can walk.

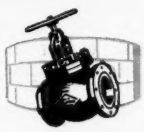
Portable Oxygen Indicator

BACHARACH INDUSTRIAL INSTRUMENT Co., 7000 Bennett St., Pittsburgh 8, Pa., has introduced its Fyrite Oxygen Indicator, a portable gas analyzer that enables rapid and accurate determination of O_2. The instrument employs the principle of chemical absorption. A sample of the gas or atmosphere to be tested is pumped into the Fyrite with the aspirator bulb. Release of the finger pressure on the connector at the end of the rubber tubing automatically locks the sample in the calibrated measuring chamber of the instrument. The Fyrite is then turned bottom-side up, and back again, which causes the absorbing fluid to mix with the sample.

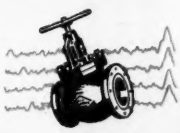
JENKINS *Pioneering*

HERE'S WHERE THESE VALVES CAN SAVE FOR YOU

WHERE external fire hazards threaten valves with abnormal heating and sudden cooling that might crack other valves.



WHERE conduction of hazardous liquids or gases, as in petroleum or chemical services, requires valves of exceptional toughness.



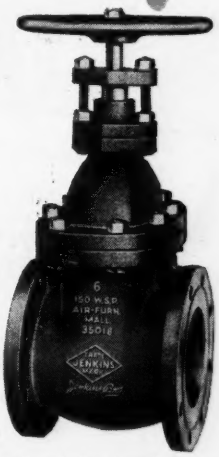
WHERE vibration, shock, or water hammer, individually or in combination, would break valves of other metals.

WHERE a higher corrosion resistance is essential, as in mine, chemical, marine, petroleum and similar services.

WHERE valves are subjected to freezing, or sudden and extreme variations of temperature are a condition of service.

WHERE valves are exposed to destructive atmospheric conditions, such as salt air or corrosive fumes from acids or chemical solutions.

provides a much-needed New Valve for war-burdened industry



Leading again in the drive for greater valve economy, Jenkins introduced the *Air Furnace* Malleable Iron Valve over a year ago.

Developed for certain "tough spots" where shock and strain run up abnormally high repair and replacement costs, these new valves have provided savings well beyond original estimates in many industries. By lasting longer, and requiring less attention, they help materially to conserve valves, and spread scarce maintenance man-hours further.

Next time you order valves for use *where steam pressure does not exceed 150 lbs., and where temperature is not above 450°F.,* check service conditions closely. If the valves must "take a beating", for any of the reasons listed at left, consider Jenkins *Air Furnace* Malleable Iron Valves.

Air Furnace MALLEABLE IRON VALVES

approved and used in these industries

Petroleum • Metal and Coal Mining • Chemical • Paper Synthetic Rubber • Food • Cement • Process Industries Power Plants • Marine • and many other fields where valves are subjected to unusual strains, vibration and destructive service conditions such as those described.

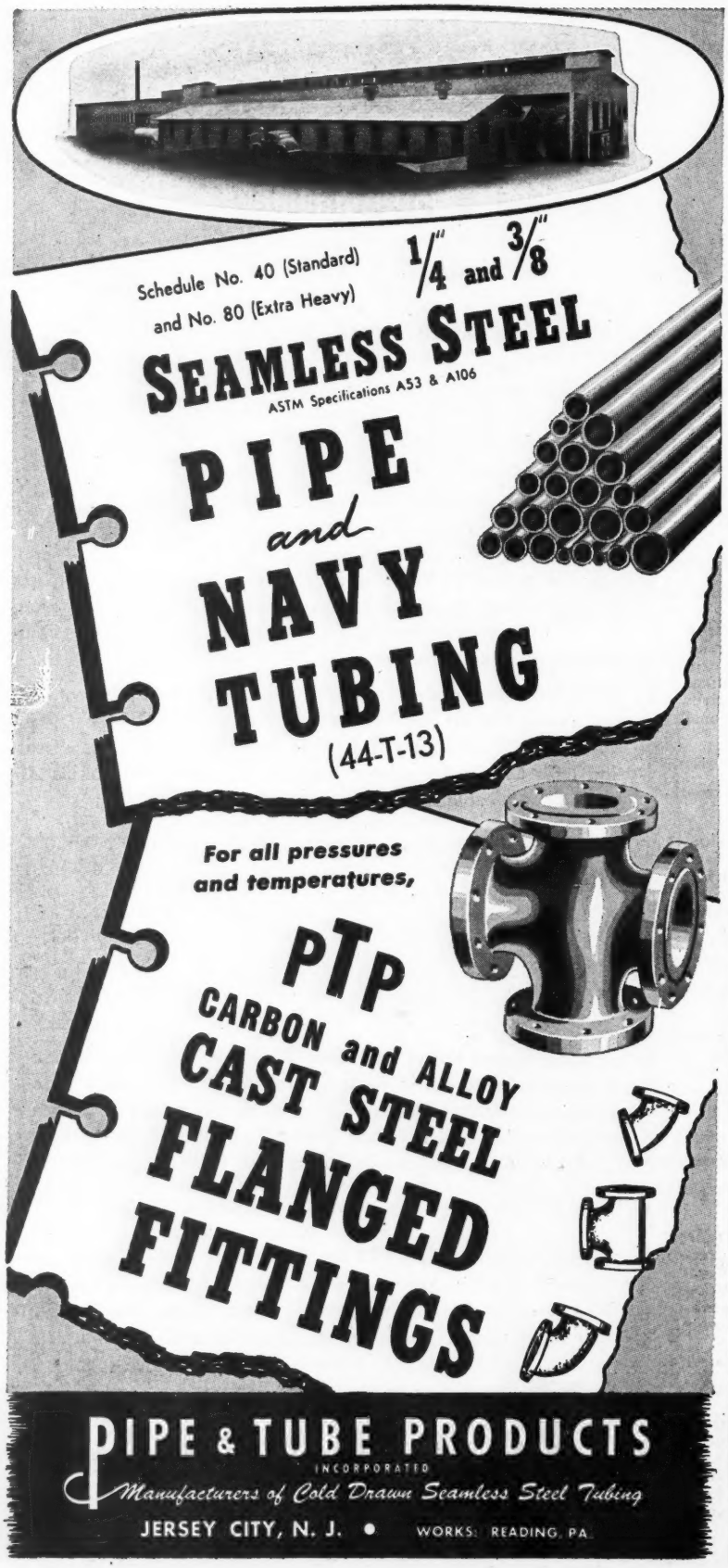
Write for Bulletin No. 192 describing this complete line, in many patterns, sizes 2 in. to 6 in. Write to Jenkins Bros., 80 White Street, New York 13, N. Y. Bridgeport, Conn.; Atlanta; Boston; Philadelphia; Chicago. Jenkins Bros., Ltd., Montreal; London.

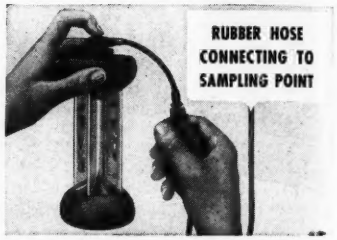
JENKINS VALVES

SINCE 1864

For every Industrial, Engineering, Marine and Commercial Service . . . In Bronze, Iron, Cast Steel and Corrosion-resisting Alloys . . 125 to 600 lbs. pressure

Sold Through Reliable Industrial Distributors Everywhere



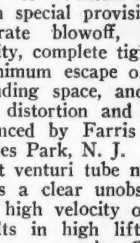


Absorption of the oxygen creates a suction which draws the absorbing fluid up into the graduation tube in an amount equal to the O_2 absorbed. Thus, the level of the fluid column shows O_2 percentage, which is read directly on the graduated scale. The standard range is 0 to 20 per cent. The entire Fyrite O_2 test, including pumping of the sample, takes about 40 seconds.

Venturi-Type Safety Valve

A LINE OF Venturi-Type Safety Valves with special provisions for constant accurate blowoff, exceptionally great capacity, complete tightness of re-seating, minimum escape of vapor into the surrounding space, and elimination of angular distortion and fouling, has been announced by Farris Engineering Co., Palisades Park, N. J.

The inlet venturi tube nozzle of this design gives a clear unobstructed port and guided high velocity of the steam, which results in high lift and correspondingly great capacity. One outstanding feature of these valves is the separator bell which causes the steam to make three changes in direction before passing into the atmosphere, and includes a drain for the condensed moisture into the body. Escape of vapor into the air is thereby minimized. The separator bell also helps to keep the spring cool by preventing steam from striking the spring.



Correct alinement of the stem, on which complete tightness of re-seating depends, is maintained by precision machine work throughout the valve, and by top guidance of the stem in two bearings.

"Vac-Veyor" Ash Handling

SEVERAL NEW DESIGN features are incorporated in the "Vac-Veyor" pneumatic ash handling system for the automatic removal of ashes, fly ash and soot, manufactured by Beaumont Birch Co., 12 South 12th St., Philadelphia 7, Pa. The ash receiver, separator and air washer are now combined in one unit and installed on top of the silo. The steam exhauster is located in the pipe line where it enters the receiver.

More inside information on POWELL VALVES

This small size 200-pound "White Star" Bronze Gate Valve looks very much like the same type of valve in other makes. But back of it—back of every Powell Valve—is nearly a century of specializing in the manufacture of Dependable valves for Industry.

The result of this Powell "know how" is a line of valves ruggedly built to give long, uninterrupted service and require minimum maintenance. These are reasons why Powell Valves are the choice of leading industrial plants throughout the nation.

The complete Powell Line includes all types of valves (Globes, Angles, Gates, Checks, Y's, etc.) not only in bronze, iron and steel but also in a wide variety of pure metals and special alloys to meet every requirement for corrosion resistance (Catalogs on request).

And if you have any unusual flow control problems, Powell Engineers will be glad to make a careful study of your requirements and design special valves to meet the conditions.

The Wm. Powell Co.

Dependable Valves Since 1846

Cincinnati 22, Ohio

This valve is especially adapted for intermediate steam, oil, water, or gas lines.

For pressures from 150 to 2500 pounds, Powell makes a complete line of Cast Steel Valves of every type.

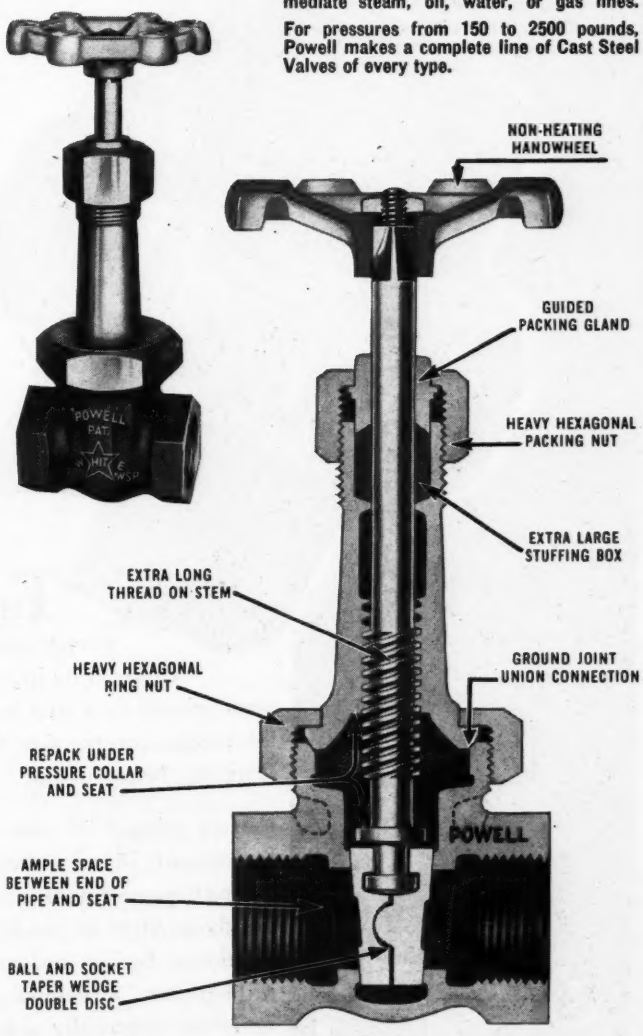

NON-HEATING HANDWHEEL
GUIDED PACKING GLAND
HEAVY HEXAGONAL PACKING NUT
EXTRA LARGE STUFFING BOX
EXTRA LONG THREAD ON STEM
HEAVY HEXAGONAL RING NUT
GROUND JOINT UNION CONNECTION
REPACK UNDER PRESSURE COLLAR AND SEAT
AMPLE SPACE BETWEEN END OF PIPE AND SEAT
BALL AND SOCKET TAPER WEDGE DOUBLE DISC
POWELL

Fig. 375
BRONZE "WHITE STAR" GATE VALVE

POWELL VALVES

DARTS ARE IDENTIFIED BY THEIR TWO BRONZE SEATS GROUND TO A TRUE BALL JOINT

THE way to recognize a Dart Union is by its two bronze seats ground to a true ball joint—the unique construction that makes Dart the *better* union.

Perfect contact of seats insures a leakproof joint without ruinous wrenching—unions uncouple instantly as often as needed in other locations. Bodies and nuts—made of high-test air-refined malleable iron—are practically unbreakable.

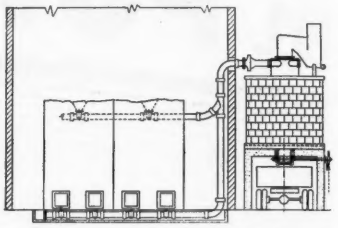
For long, trouble-free service, and consequent low cost, always specify Darts.

"IT PAYS TO BUY DARTS"

DART UNIONS

E. M. DART
MANUFACTURING COMPANY
PROVIDENCE 5, R. I.

The mixture of ash, steam and air enters the circular receiver tangentially at high velocity, and the centrifugal action throws the heavy ash particles out of the steam and air before it has traveled more than half way around the receiver. The ash falls directly into the silo while the baffle plates in the separator, in conjunction with the greatly reduced steam-air velocities, cause practically all of the light ash to settle into the silo through the conical baffle. The steam-air mixture then passes into the washer, where any remaining light fly ash can be removed by sprays and washed away through 4-in. soil pipe line.



In operation, there is enough moisture imparted by the steam to the ash to settle out practically all light ash. There is, however, no wetting of the material, which minimizes the possibility of packing and freezing in the silo.

The four-foot diameter receiver is constructed of ¾-in. hard iron and is fitted with white iron baffles. The separator consist of a 24-in. shell, constructed of ⅜-in. steel plate, the base of which extends down into the receiver. The air washer is 24-in. square, constructed of No. 12 gage welded steel plate. It is equipped with connection for a 4-in. soil pipe to drain off the spray water.

Controllable Capacity Pump

A 3-IN. STROKE, 20 hp unit has recently been added to the line of controllable capacity pumps manufactured by Aldrich Pump Co., Allentown, Pa. Originally introduced four years ago, the line now consists of 20 hp, 40 hp, 60 hp and 100 hp units which cover a wide range of capacities at various pressures up to 15,000 psi.

Primarily used for boiler feeding, desuperheater feeding, pipe line, process charging and proportioning, these pumps are being installed in increasing numbers wherever accurate, automatic control of delivery is important. Operated at constant speed, from no-load to full rated capacity, power consumption of these pumps is practically proportional to discharge.

Condensate Return System

THE COCHRANE-BECKER units manufactured by Cochrane Corp., 17th & Allegheny Ave., Philadelphia 32, Pa., are designed to return the condensate from process equipment operating at pressures up to 200 psi directly back to the boiler without flash loss and with all of the sensible heat contained in the original steam.

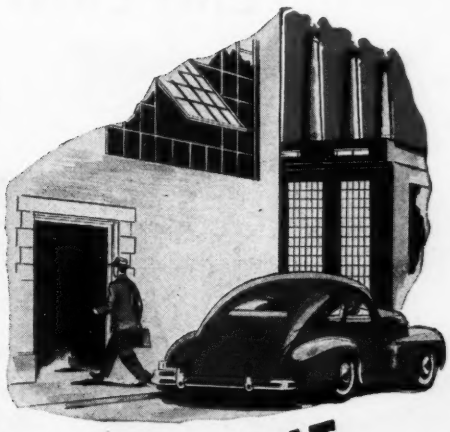
All condensate, non-condensible gases and entrained air are handled by the jet at high temperature with a

2 WAYS TO IMPROVE COMBUSTION *whatever your fuel*

PREHEAT ENGINEERING DESIGN

All fuels burn better with preheated combustion air, and it is a "must" for many of them, such as high-moisture powdered coal. In planning new steam generation plants or other furnaces for oil refineries, chemical plants, etc., remember that the *continuous regenerative counterflow* principle of the Ljungstrom Air Preheater assures maximum heat transfer with minimum weight and size. Flexible and compact, it may be used in a wide range of applications. With the Ljungstrom it is possible to obtain preheated air up to 1500 deg. F.

All boiler manufacturers can furnish you designs incorporating the Ljungstrom Air Preheater. Or, the engineering staff of The Air Preheater Corporation is prepared to assist you, your consulting engineers or your boiler company, in applying standard or special types of Ljungstrom Preheaters to your fuel conservation needs. Our engineers are ready to work with yours to help you make better use of low-grade, more abundant fuels and to help you plan for future modernization of, and additions to, your steam generating plants.



PREHEAT ENGINEERING SERVICE

Today, when boiler efficiency must be stepped up, and kept up, to generate steam with the current inferior fuels, the need for expert service has increased. To assist you in securing efficient operation under abnormal conditions, The Air Preheater Corporation has expanded its service facilities, so that an Air Preheater Service Engineer, whose sole responsibility is Ljungstrom Preheaters, is quickly available to keep your Ljungstrom operating smoothly, and at peak efficiency.

NEW! When, for reasons of fuel conservation Ljungstrom Preheaters are operated with lower gas exit temperatures than those for which they were designed, deposits sometimes form. To do an even better job of removing these deposits, a new, single-nozzle cleaning device is available for immediate installation on *all* Ljungstroms. Full details will be sent upon request.

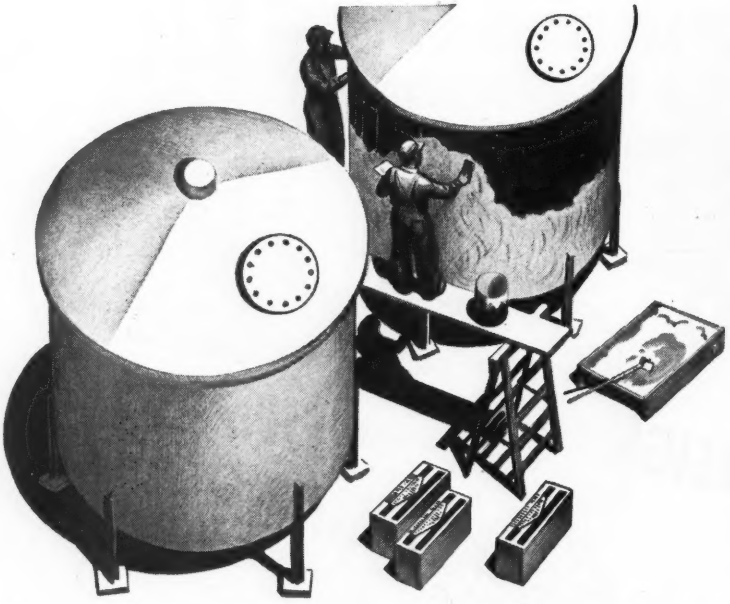
THE

AIR PREHEATER

CORPORATION

Executive Offices: 60 East 42nd Street, New York 17, N. Y. • Plant: Wellsville, New York

★FOR **LOW** OR HIGH TEMPERATURES



★ this one-block insulation

Most insulating blocks are made for one particular temperature range. MONO-BLOCK is effective at all temperatures up to 1700° F. The use of a single material reduces installation time and cost.

Mono-Block is felted by a patented process—with long straight fibres of high-temperature-resisting B-H *black* rockwool in interwoven layers. The result is that millions of dead-air cells provide an effective heat barrier. This produces an unusually low K Factor . . . At a mean temperature of 200°, for example, the conductivity factor is .370.

The low alkalinity factor of the *black* rockwool fibres insures their stability under severe conditions of temperature, moisture and humidity.

This strong, but lightweight block cuts easily in straight lines or in odd shapes —yields readily to rivet heads or other surface irregularities. This means quick, sure application; when cemented with B-H Bond-Tite to a clean surface, wiring is often unnecessary. Mono-Block is supplied in a range of sizes and thicknesses . . . . Write for full information and generous sample.

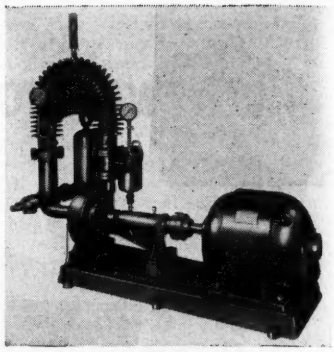
For insulating cement that stays put—easy to apply on hot or cold surfaces—write for folder on B-H No. 1 Cement.

Address: **Baldwin-Hill Co., 577 Klagg Ave., Trenton 2, N. J. Plants in Trenton, N. J.; Kalamazoo, Mich.; Huntington, Ind.**

Baldwin-Hill

BH **COMPANY**

HEAT & COLD INSULATIONS



constant differential maintained across the equipment creating positive drainage with entrained air automatically discharged from the closed circuit before return to the boiler.

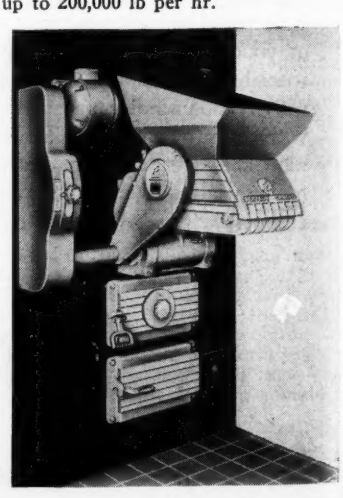
Because of the high back pressure maintained against the equipment with constant flow of gases and liquids, there is no appreciable pressure drop in the steam chambers, as is the case when discharging to atmosphere or a low pressure.

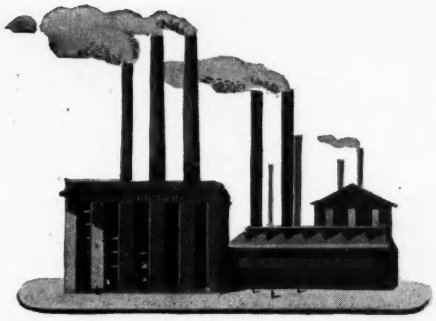
Hence, heat transfer rates are higher and more uniform, resulting in hotter heating surfaces, greater production at the same steam pressures, with less fuel costs.

New Spread Stoker

A NEW SPREADER-TYPE stoker based on one of the latest improved methods of low cost steam production, and backed by 38 years of stoker engineering experience, has been announced by American Engineering Co., Philadelphia 25, Pa. This modern, completely automatic stoker efficiently burns all kinds and grades of solid fuels, including by-products and plant refuse, whether wet or dry. This versatility permits the utilization of favorable market prices and fuels available in any locality.

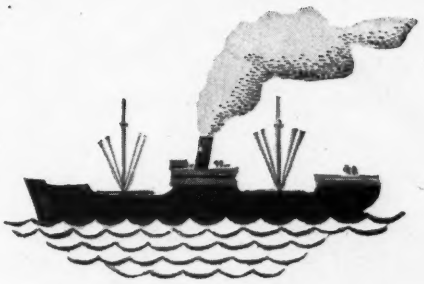
Extremely clean and quiet in operation, the AE Perfect Spread Stoker gets up steam quickly with its combination of an all-speed, non-clog feed, uniform fuel spread by the reliable overthrow method, and thorough combustion through forced draft and exclusive grate design. The stoker can be easily installed under most existing boilers to produce steam from 175 hp up to 200,000 lb per hr.





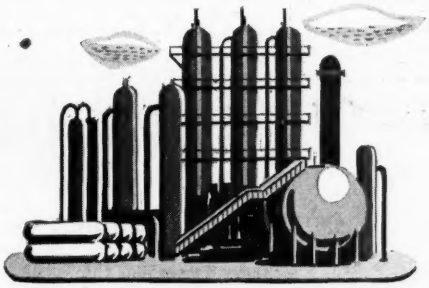
CURED BY A NOSE FOR TROUBLE

Consistent failure . . . at the same definitely-located points . . . led this power plant to apply to Scovill for help. Scovill *Service in Men* helped determine that chlorine leakage was causing the trouble. A few simple installation changes cured the trouble.



DOUBLE RIDE WITH CUPRO-NICKEL

Admiralty tubes operating in 210°F., vapor-side, lasted only 8 months. Contaminated salt to brackish circulating water invited permeable scale formation, favoring dezincification. Scovill *Service in Metals* recommended 70-30 Cupro-Nickel, lengthening service life 100%.



CONCERNING AN INFORMATION EXCHANGER

Many a refinery man, reading Scovill's Condenser Tube Booklet, has widened his knowledge of certain phases of heat exchanger tube service. Scovill *Service in Manuals* reports regularly on studies of Scovill research laboratories plus experiences of Scovill service engineers.

All three types of problems...selection of the proper metal...correct installation practice... desire for further information—are directed to Scovill because it is

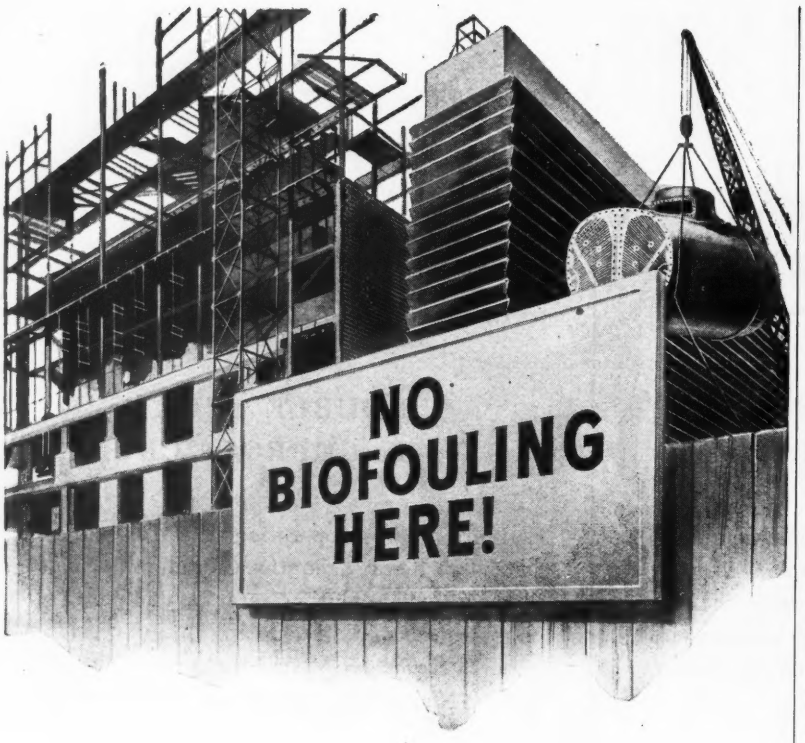
One Company Which Gives You

ONE PRODUCT

. . . Condenser Tubes

THREE SERVICES

For a free copy of the new Scovill Condenser Tube Booklet, write SCOVILL MANUFACTURING CO., 17 Mill St., Waterbury 91, Conn.



Wallace & Tiernan Desliming Installations *never give slimes a chance* to deposit in condenser tubes or on heat exchanger surfaces. When included in your specifications, reductions in size, weight and investment in basic heat exchange equipment are positive.

Whether you are building a new plant or increasing the production of your present one, Wallace & Tiernan engineers will gladly give you technical information on the prevention of biofouling and bacterial corrosion in cooling-water systems. CD-11

WALLACE & TIERNAN PRODUCTS, INC.

Manufacturers of Chlorine and Ammonia Control Apparatus

Belleville 9, New Jersey ● **Represented in Principal Cities**

Other important advantages that cut fuel bills and boost boiler room operating efficiency include: fully protected mechanism, accessible without tools; simple controls; water cooling; and long-life grates with power dump.

General Precision Equipment Corp. Acquires Askania

ALL THE STOCK of the Askania Regulator Co. of Chicago, Ill., has been acquired by General Precision Equipment Corp. of New York. The present management of Askania will continue to be in charge of operations.

Askania Regulator Co. is manufacturer of hydraulic control systems used largely in power plants for the accurate control of combustion but the effective operation of the control apparatus has broad application in many other industrial fields.

In recent months a new electronic tube was developed by Electronbeam, Ltd. an associated organization. This tube is basically a stable DC amplifier of the cathode ray type. Due to its self-compensating features it is practically independent of tube characteristics, heater or other voltage variations and it can be controlled by other electrostatic, electromagnetic or magnetic fields, thus broadening the field of electronic circuits.

In the power field the tube can be used to control constant voltage, current or variable frequencies ranging from 1 cycle per year up to radio frequencies as well as for control of the speed of motors. Special circuits will permit the simultaneous control of several motors and conditions by means of one tube.

Obituaries

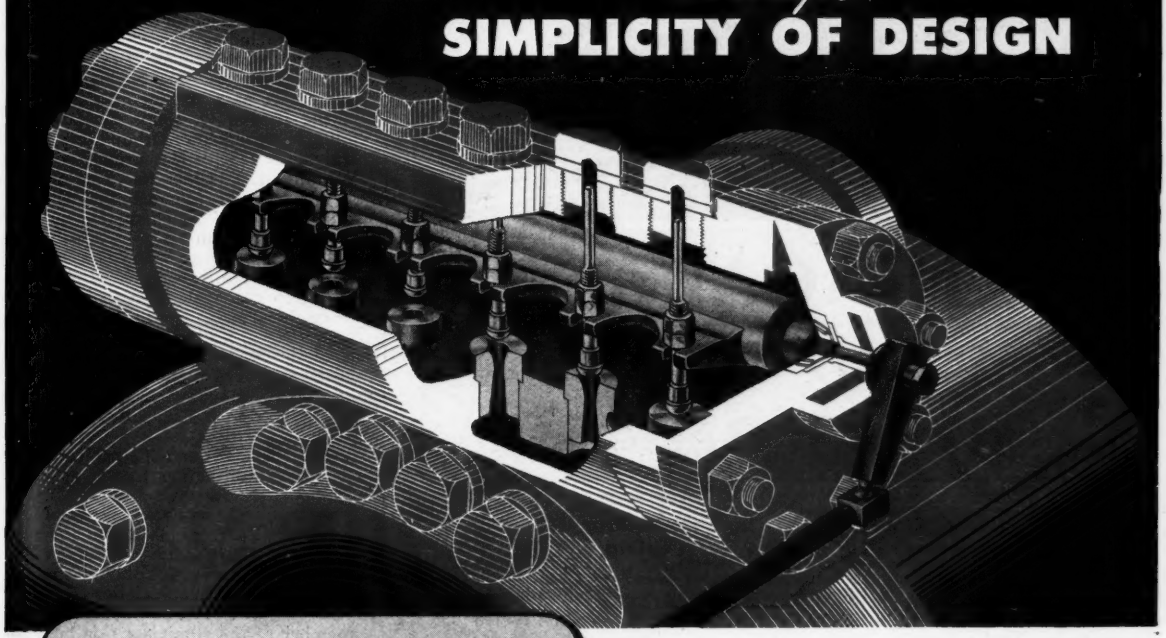
Walter H. Girdler, Sr.

WALTER H. GIRDLER, SR., president of Tube Turns and the Girdler Corp., Louisville, Ky., died January 7 at the age of 58 years. Mr. Girdler started his career as proprietor of a general store at Somerset, Ky., where he went after graduating from high school in Louisville. He returned to Louisville in 1916 and a year later bought an interest in the Kentucky Hydrogen-Oxygen Co. His industrial holdings later included many manufacturing plants employing thousands of workers.

Charles F. Scott

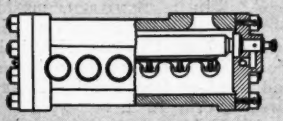
DR. CHARLES FELTON SCOTT, Professor Emeritus of Yale University died in a hospital in New York City on December 17 at the age of 80 years. Born in Athens County, Ohio, on September 19, 1864, the son of William Henry and Sarah (Felton) Scott, Dr. Scott received his early college training at Ohio University from which he transferred to Ohio State University from which he received his A. B. degree. Subsequent studies and engineering achievements brought him degrees and honors from Johns Hopkins Univ., Yale Univ., Univ. of Pitts-

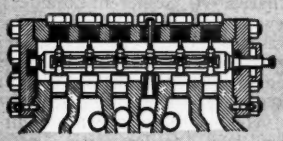
SENSITIVITY OF CONTROL *through* SIMPLICITY OF DESIGN



This HENDY Turbo-Generator feature will pay you dividends

The steam-control valve mechanism of the Hendy turbo-generator is operated by a rocker shaft. In this design there are no valve stems or lifter-bar mechanisms passing through the steam chests; thus friction loss is eliminated and the sensitivity of the system is correspondingly increased. The stainless-steel rotating shaft that lifts each valve successively from its seat is carried in nitrided bearings, insuring free operation in high temperatures and eliminating shaft stuffing or packing boxes.

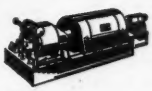




Because of the extreme simplicity of this design, valve adjustments are easily made, and heavy rocker arms, lengthy control linkages, and wasteful steam leakages are eliminated.

This worth-while Hendy feature is only one of many that contribute to lower maintenance costs, greater efficiency in operation—that pay you dividends. Watch succeeding advertisements for details of other dividend-paying Hendy features.

Further descriptive information is available. When requesting detailed information and prices please indicate electrical requirements, steam conditions, and type of service involved.



Developed recently to meet war needs for a matched turbo-generating set of utmost reliability, Hendy turbo-generators are setting new high standards of performance. By simplification of design *throughout*, operating efficiencies are *raised* and maintenance and service problems are *reduced.* Built in one of America's best equipped shops by a corps of skilled craftsmen, these units feature many advancements in turbine, reduction-gear and generator design . . . combined into one complete plant that has received immediate approval by operating engineers.

Hendy turbo-generating plants are available for marine or stationary applications in sizes from 250 to 750 kw. Investigate *now* the many advantages to you of installing Hendy equipment.

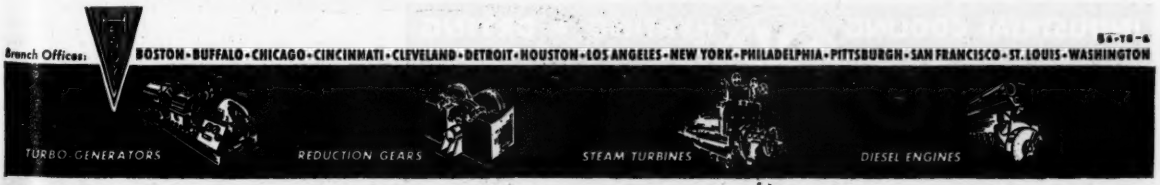
JOSHUA HENDY IRON WORKS

ESTABLISHED 1856

SUNNYVALE, CALIFORNIA

55-YB-6

Branch Offices: BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND • DETROIT • HOUSTON • LOS ANGELES • NEW YORK • PHILADELPHIA • PITTSBURGH • SAN FRANCISCO • ST. LOUIS • WASHINGTON



NIAGARA
Evaporative COOLING
Does It Better

Cooling Fluids with Closer Control of Temperature

Niagara Aero Heat Exchanger cools liquids or gases to within 10° of atmospheric wet bulb temperature and holds them to a tolerance of 2°F. with the NIAGARA "Balanced Wet Bulb" control.

Holding Temperatures of Quenching Baths

Hundreds of heat treaters now use Niagara Aero Heat Exchanger to cool and control quenching baths, improving quality, increasing production, avoiding troubles, and saving cooling water expense.

"BALANCED WET BULB" TEMPERATURE CONTROL

U. S. Patent Re-issue No. 22,533
U. S. Patents 2,166,397; 2,296,946;
Re-issue No. 22,553
Other Patents Pending.

Compressed Air After-Cooling

Niagara Aero After Cooler cools compressed air colder to eliminate one-half the moisture permitted by conventional methods and controls jacket water temperature. Saves cooling water cost.

Condensing Refrigerant Gases

Niagara Duo Pass Aero Condenser saves power, increases compressor capacity, saves condensing water cost, increases plant production. Duo Pass prevents scale formation; assures full capacity always.

OTHER USES OF NIAGARA AERO HEAT EXCHANGERS include chemical and industrial process liquid cooling, engine jacket water cooling, hydraulic fluid cooling, transformer oil cooling, lubricating and cutting oil cooling, water jacketted bearing and furnace cooling, vapor and steam condensing.

Consult your Niagara Engineer for information on any application of air engineering equipment, including air conditioning for industrial processes, NIAGARA "No-Frost" refrigerating systems for storage or process, heating, cooling, drying or humidification.

NIAGARA BLOWER COMPANY

Over 30 Years of Service in Industrial Air Engineering

DEPT. PP-25, 6 E. 45th St. NEW YORK 17, N. Y.

Field Engineering Offices in Principal Cities

INDUSTRIAL COOLING HEATING • DRYING
NIAGARA
HUMIDIFYING • AIR ENGINEERING EQUIPMENT

burgh, Stevens Inst. of Technology, Brooklyn Polytechnic Inst., Ohio State Univ., and Rose Polytechnic Inst.

Although he spent from 1888 to 1911 in various engineering positions up to consulting engineer with the Westinghouse Electric and Mfg. Co. and was the inventor of many electric devices including the "Scott Connection" for transformers, Dr. Scott was at heart an educator having initiated this career as a teacher of apprentices in the B. and O. shops in Baltimore following graduation from Ohio State Univ. in 1885. He organized The Westinghouse Club for Engineering Graduates and founded the Electric Journal both of which carried on educational programs.

It was no surprise to his associates when he became professor of electrical engineering at Yale University in 1911 where he remained until 1933 when he was made professor emeritus. His interest in education did not stop there, however, for since his retirement he has been a moving spirit in nearly all the activities of the professional engineering societies having to do with higher education and the application of scientific information to the problems of modern industry.

Dr. Scott was president of the Engineers Soc. of Western Pennsylvania in 1902; president of AIEE, 1902-03; chairman of building committee of Engineering Societies' Building, 1903-07; president of SPEE, 1921-23; member of the administration board of the American Engineering Council, 1921-33; was awarded the Edison Medal by AIEE in 1929, and Lamme Medal by SPEE in 1930. As an inventor, engineer and educator, Dr. Scott had made contributions to the advancement of the engineering profession that entitle him to a prominent place in the history of our country's development.

G. Arthur Schieren

G. Arthur Schieren, president of the Charles A. Schieren Co., died December 7 at Doctors Hospital, New York City. He was sixty-six years old and lived at Beachleigh, Kings Point, Great Neck, L. I.

Mr. Schieren was a son of the late Charles A. Schieren, founder of the seventy-five-year-old belting firm. He was graduated from Cornell University with a degree in mechanical engineering in 1900 and entered the firm immediately afterward.

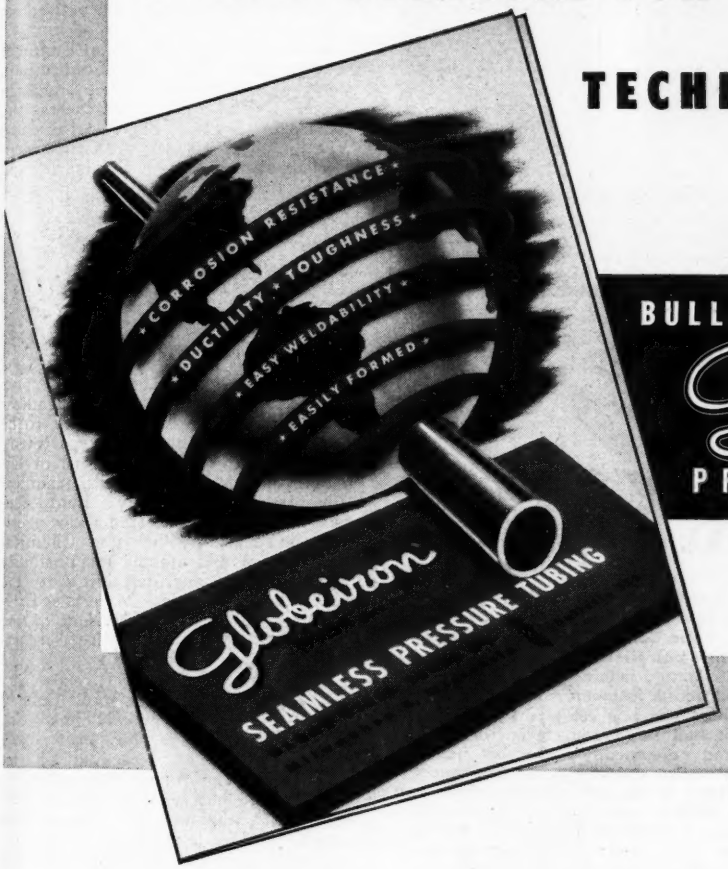
He was a former president of the American Leather Belting Association, and was a member of the American Society of Mechanical Engineers.

Howard McWilliam Wylie

Howard McWilliam Wylie, former vice-president in charge of sales of the Nash Engineering Co. of South Norwalk, Conn., died on Christmas Day at his home, 51 Elmwood Avenue, after a long illness. He was born in Poughkeepsie, N. Y., 59 years ago.

Mr. Wylie received a B. S. degree from New York University in 1906 and an M. E. in 1908. He had served as a design and erection engineer with the Westinghouse-Church-Kerr Co., an erection engineer with Bliss & Griffiths and the Wirebound Box Corp., secretary of the Howard Automobile Co.,

A NEW BULLETIN FOR ENGINEERS and TECHNICAL MEN



BULLETIN 113 DESCRIBES

Globeiron

SEAMLESS PRESSURE TUBING

GLOBEIRON Seamless Pressure Tubing (99.5% pure iron) is manufactured by piercing solid rounds and rolling them into tubes. It is pressure tubing that is easily formed or welded and offers unusual qualities of corrosion resistance — ductility — toughness.

Boiler tubes of Globeiron are easily rolled in and beaded; condenser tubes may be expanded, flared, or flanged readily because of the ductility and toughness of Globeiron.

Bulletin 113 gives the complete facts on Globeiron advantages — write for your copy today.

GLOBE TUBES

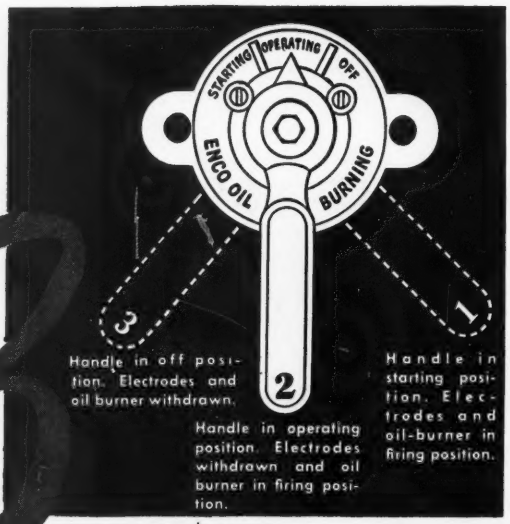
★ STAINLESS TUBES
★ BOILER TUBES
★ GLOBEIRON TUBING
★ GLOWELD TUBES
★ CONDENSER AND HEAT EXCHANGER TUBES
★ MECHANICAL TUBING

GLOBE STEEL Tubes

5015

GLOBE STEEL TUBES CO., Milwaukee 4, Wis., U. S. A.

Hand Control Valve for cylinders . . . wall mounting . . . oil burner ignition system.



3 Step IGNITION SYSTEM FOR PULVERIZED COAL, OIL, OR GAS

FAST SAFE POSITIVE

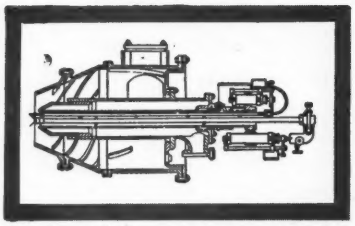
With an Enco Ignition System, operator can light off any burner by movement of a Hand Control Valve, located close to the pulverized-coal mill and fan controls, and within view of the instrument board. Automatically, a powerful ignition spark is established, and the light fuel turned on. Both are interlocked electrically — **the oil valve cannot be opened until the spark current is on and the atomizer is in firing position.** After the oil flame is established, a second movement of the control valve retracts the electrodes, leaving the atomizer in operation.

After ignition of the pulverized coal is established, a third movement of the control valve shuts off the oil and retracts the atomizer out of the hot zone, leaving the unit ready to repeat the operation as may be needed.

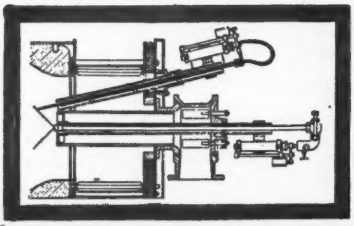
The Enco Ignition System has a wide range of application. Pulverized coal, blast furnace gas or any liquid fuel may be ignited by the unit, or the spark alone may be used to ignite natural or refinery gas. The ignition flame can be changed gradually from light to heavy fuel oil if continued operation under heavy load is required. The ignition flame also can be used as a substitute for principal fuel in emergencies.

Bulletin on request.

Atomizer and electrodes in the central tube.



Atomizer and electrodes in separate tubes.



THE ENGINEER COMPANY
75 West Street, New York 6, N. Y.

Canada: F. J. RASKIN, Inc.
370 Rachel E., Montreal, P. Q.

Enco OIL BURNING EQUIPMENT

design engineer for the Roland Gas and Electric Co., and sales engineer for the Bishop-Babcock Co. In 1915 he joined the New York office of the Nash firm, as a sales engineer, and later became manager of the office.

In 1919 Mr. Wylie became general sales manager. He was elected a director in 1921, assistant secretary in 1922, and vice-president in charge of sales the next year. Mr. Wylie retired as vice-president and as director in 1942.

A Registered Professional Engineer in both New York and Connecticut, he was a member of the American Society of Mechanical Engineers, the American Society of Heating and Ventilating Engineers, the Connecticut Society of Professional Engineers, and the Engineers Club in New York City. He also belonged to the Zeta Psi Club.

MANUFACTURERS' *News*

A new department in the organization of the General Electric Co., to be known as the Chemical Department, has been created by the Board of Directors and Dr. Zay Jeffries, technical director of the company's Lamp Department, has been elected a vice president in charge. The new Chemical Department will assume responsibility for the operations pertaining to the Resin and Insulating Materials Division and the Plastics Division of the Appliance and Merchandise Department.

Frank P. Rhame, a Director and Vice-President and Assistant General Manager of The Lunkenheimer Co., valve manufacturers, has been made General Manager, succeeding Charles A. Brown, who retired December 31. Mr. Rhame has been associated with The Lunkenheimer Co. for over 25 years. Homer E. Lunken, a Director, succeeds him as Assistant General Manager.

Carra L. Lane, a production man of wide experience in valves and related products, has been named Works Manager, succeeding George A. Seyler, who announced his retirement as Vice-President in Charge of Manufacturing in September, effective December 31.

Fred H. Hehemann, Assistant Chief Engineer, becomes Chief Engineer, succeeding Jerome J. Aull, who retired December 31 after nearly 50 years of service with The Lunkenheimer Co. Hehemann has been with the company since 1904.

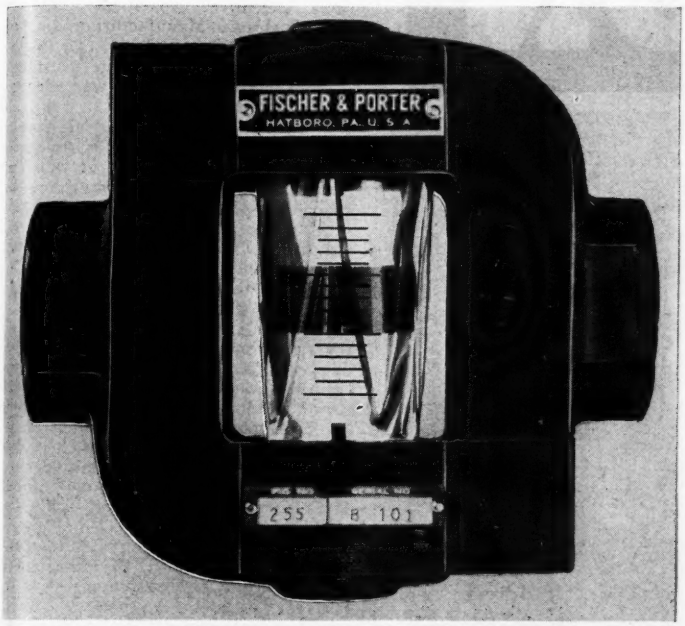
Harry A. Burdorf, widely known in the valves and fittings industry and distributive channels, remains as a Director and Vice-President in Charge of Sales.

Eshelby F. Lunken remains as a Director and President of the company; Chester C. Isekeit as a Director and Treasurer; and Charles W. Burrage as Secretary.

Clarence E. Searle has been elected president of Worthington Pump and Machinery Corp., to succeed Harry C. Beaver who was elected vice chairman of the Board of Directors, and chairman of Management Committee.

The ROTASIGHT Flow Indicator

—an inexpensive instrument that shows the true flow rate!



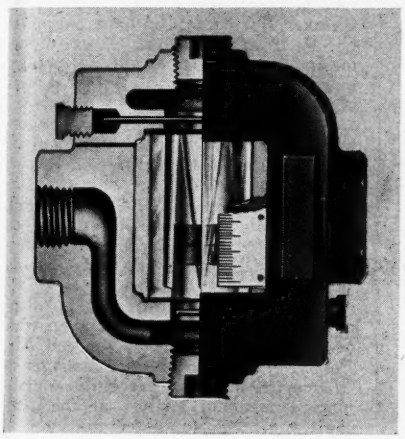


Illustration 1—Cut-away view of the Rotasight. Notice the flow passage through the metal fitting, the precision-bore fluted metering tube, the detachable metering scale, and the way the float stops are installed.

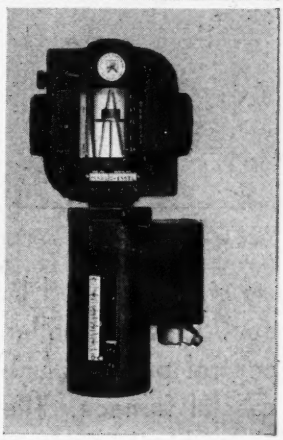


Illustration 2—The Rotasight Alarm with standard extension showing the adjustable alarm switch and pointer for reading the alarm position.

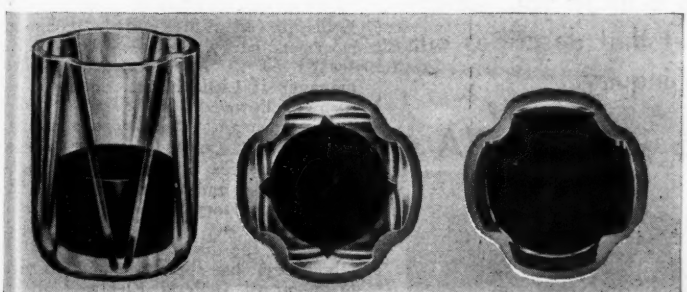


Illustration 3—Side and top views of the special precision-bore V-port fluted tube and the float used in the Rotasight. Top views show the way the space for flow passage (shown in red) increases from low to high flow. Middle photograph shows the float in the lowest position and the right hand photograph shows the float in its highest position in the tube.

IF YOU have certain flows that are not too critical but where a comparative idea of the flow rate would be reassuring and therefore worth a small investment, then the Rotasight is just what you have been seeking. It is a short-scale rotameter with a float which responds immediately to flow changes and which *continuously* indicates the true flow rate.

The Rotasight is compact, and very easy to install since it may be piped horizontally or vertically as desired. Best of all, it is very moderate in price—hardly more than the flapper and wheel-type sight glasses which it replaces because of its more accurate indication of the actual flow rate.

One of the greatest uses of the Rotasight has been as a flow rate alarm. An armature attached to the Rotasight float can be made to trip an external magnetic switch at any point in the flow range of the Rotasight (see Illustration 2) and thus actuate electric relays to sound an alarm, or to start or stop electrical equipment. It is the most practical, inexpensive flow rate alarm available because it responds to flow rate changes *only* and because its flow calibration is a straight line, thus making it equally sensitive at all points of its flow range, whether high or low.

The Rotasight is available in bronze or iron, in sizes from ¼ inch to 2½ inches, with flow ranges starting at 0.03 G.P.M. of water or 0.06 C.F.M. of air in the smallest size and reaching a maximum of 60 G.P.M. of water or 135 C.F.M. of air in the largest size. An idea of the physical dimensions of this instrument may be obtained from the 1 inch size which is approximately 6 inches by 6 inches by 3 inches wide. Standard Rotasights can be delivered in any size within four weeks.

The Rotasight is being used with great success by many leading manufacturers of chemicals and process equipment in such services as water flows to pump sealing glands; lubricants to bearings on turbines, compressors and pumps; cooling water to ignitron tubes, furnace blocks and other water-cooled equipment; distribution of flow to spray nozzles; distribution of gas flows to furnace batteries; overflow warnings; backwashing of small filters, and in many other applications where the certain ability to duplicate the flow rate every day is important or where flow stoppage or flow excess will cause damage or wastage.

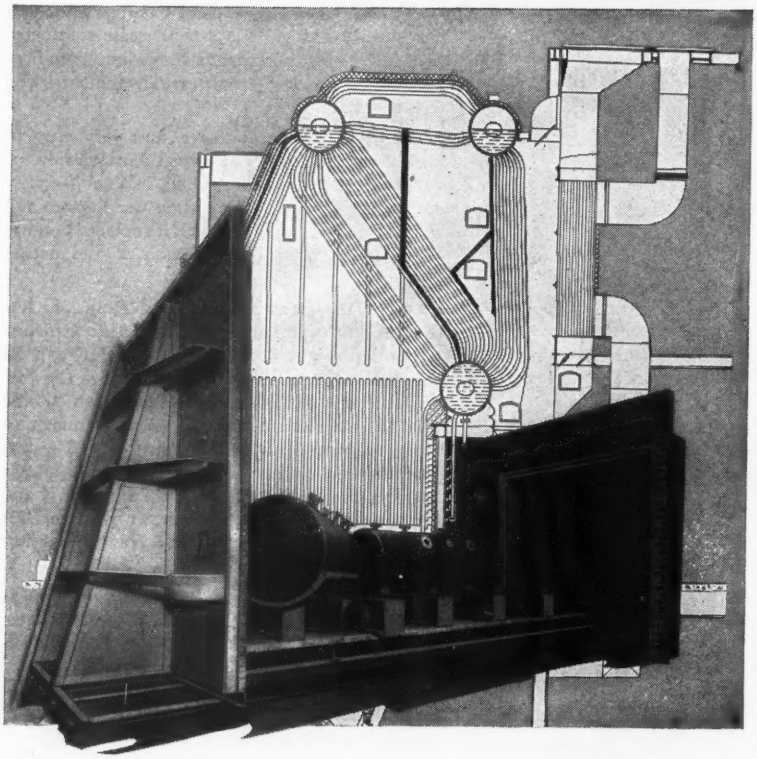
The full and interesting details of construction, capacities, dimensions, prices and applications of the Rotasight are given in our new and profusely illustrated Catalog 92-C—just write us for your free copy.

FISCHER & PORTER CO.

5902 County Line Rd., Hatboro, Pa.

Fischer & Porter Company has pioneered EVERY basic rotameter improvement!

UNION



ALL UNION WELDED VESSELS are stress relieved in this large zone controlled furnace. Gas fuel under six point potentiometer automatic control provides uniform temperature throughout this special furnace. The use of gas assures a neutral atmosphere within the furnace and prevents oxidation and scaling of the charge. Union, strategically located, is equipped to build to your exacting specifications. Write for booklet that describes our facilities. Send us your inquiry.

UNION IRON WORKS ★ ERIE, PA ★

BOILERS

PRESSURE VESSELS • PLATE FABRICATION

Mr. Beaver has been president of the Corporation since 1931, and Mr. Searle has been vice president in charge of sales since joining the Worthington organization in 1932, following a long period of service in various executive capacities with the Allis-Chalmers Manufacturing Co. of Milwaukee, Wis.

Hobart C. Ramsey, vice president in charge of operations, was elected executive vice president.

Edwin J. Schwanhausser, vice president in charge of the Corporation's manufacturing and sales operations in Buffalo, was elected vice president in charge of sales.

Leslie C. Ricketts, manager of the Corporation's Harrison Works, was elected a vice president.

All of these elections became effective January 1, 1945.

Allison L. Bayles, vice president of the American Engineering Co., Philadelphia, Pa., recently announced the consolidation of all of the company's varied engineering functions into one Engineering Department. Concurrently the election of H. E. Preston as vice president in charge of engineering was also made public. As now aligned, Mr. Preston's supervisory staff includes H. F. Lawrence, chief engineer; E. L. Midgette, director research & design; J. E. Beck, manager of erection & operation; T. A. Harvey, estimate engineer; P. N. Oberholtzer, hydraulics engineer; C. A. Boecker, materials handling engineer; C. V. Koons and R. C. Lamond, marine engineers; F. L. Hemings, manager of design; R. W. Reid, test engineer.

Crane Co. announces several important changes in the management of its branches, due to the retirement of two of its branch managers.

In Los Angeles, D. D. Updegraff, manager since 1936, has resigned on the advice of his physician, and is succeeded by R. E. Penny, manager of Jacksonville branch since 1941.

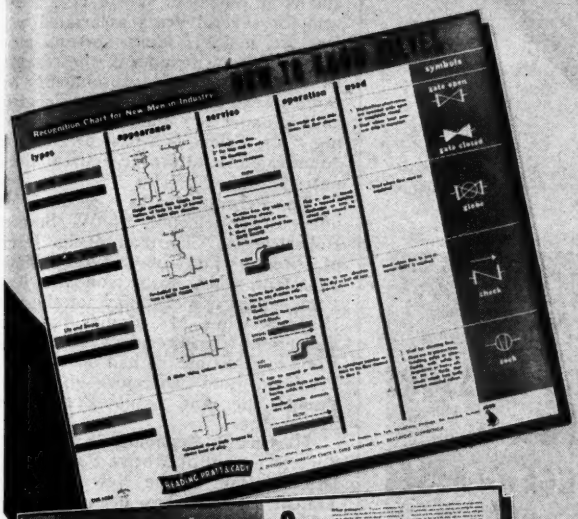
L. R. Bauer, who served as manager at Brooklyn and New Haven, now goes to Jacksonville to succeed Mr. Penny. J. J. Murray, once manager at Worcester, and more recently a planning department analyst at the Chicago works, is appointed manager at New Haven.

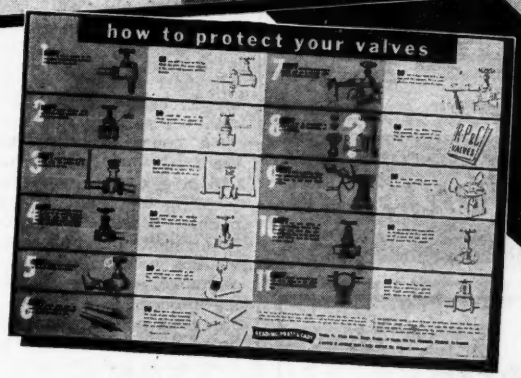
In Memphis, Tenn., F. A. Duncan, manager since 1922, retires after 43 years of service. He joined the Crane organization October 1, 1901, at St. Louis, moved to Memphis in 1905, and has been there ever since. He is succeeded by O. F. Woodyard, former manager at Little Rock, Ark., who in turn is followed by A. C. Gribble, who was a salesman at the Houston branch.

Dr. W. D. Coolidge retired December 31 as vice president of General Electric Co. and director of the research laboratory, a position he has held since 1940. Dr. C. G. Suits, assistant to the director of the research laboratory, has been elected a vice president of General Electric and in that capacity will be in charge of the Company's research laboratory.

David C. Prince, vice president of General Electric on January 1 took charge of the company's General Engineering Laboratory, the activities of

So that valves may *Serve* you better

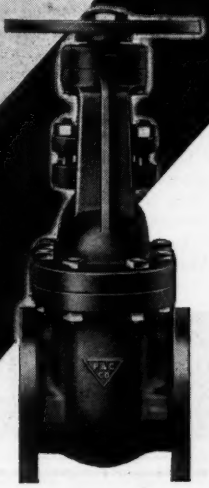




NOT only good valves, but best possible valve service—that's the **R-P & C** idea. A valve can do its best only on the job for which it was designed—and then only if correctly installed and properly used.

There is a good **R-P & C** valve for practically any job. And there is an **R-P & C** expert ready to advise on any valve question. However, if your problems are simple ones, perhaps the answers may be found on one or another of the charts shown on this page.

Thousands of these charts have been requested and received by valve users. If you do not have them, we will send you one or a complete set. Apart from their practical everyday use, they will remind you of a source for good valves and expert valve information.



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READING CAST STEEL VALVES AND FITTINGS • PRATT & CADY BRASS AND IRON VALVES
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AMERICAN CHAIN & CABLE • BRIDGEPORT

PYREX High Pressure Gauge Glasses are specially designed, manufactured and tested to stand up under the severe punishment of high pressure service.

PYREX High Pressure Gauge Glasses resist pitting and clouding, and retain their crystal clearness throughout their entire life. Their resistance to thermal shock minimizes breakage due to sudden temperature changes. Because of machine drawn accuracy, they are easy to install, and danger of installation strain is reduced to a minimum.

For high pressure duty, in locations where specially high visibility is needed, or for moderate pressure conditions, there is a specific PYREX or CORNING Gauge Glass that has exactly the characteristics to give you long lasting, trouble free, economical service. They are stocked by all leading mill supply houses.

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A complete line to solve your particular gauge glass needs.

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CORNING Glass Works Corning, New York

Pyrex Gauge Glasses

CHANGE OF ADDRESS

To avoid missing an issue or paying for forwarding postage be sure to send a change of address to our office. Changes received by the 20th of the month can be made effective for following month's issue.

POWER PLANT ENGINEERING

which will be broadened to include the requirements of the entire company.

Mr. Prince was graduated from the University of Illinois in 1912, since which his service with GE has been continuous except for five years beginning in 1914 which he spent with the Illinois Public Utilities Commission and as an officer in World War I. He was for several years associated with Dr. E. F. W. Alexanderson, radio pioneer, was a member of the research laboratory staff and subsequently became research engineer on switchgears and manager of commercial engineering. Mr. Prince is a past president of American Institute of Electrical Engineers.

The Permutit Co. of New York, announces the election of W. Spencer Robertson as Chairman of its Board of Directors and Henry W. Foulds as President. Mr. Robertson has been President of the company for the past 15 years while Mr. Foulds has been Executive Vice-President since 1935. Prior to that time, he had been a Vice-President and Director of Goulds Pumps, Inc., and a Vice-President of Servel, Inc.

Herbert B. Reynolds, until recently Superintendent of Motive Power of the IRT Division of the New York City Transit System, has been given the duties of Superintendent of Power Generation for the entire system which is a consolidation of the Interborough Rapid Transit Co., the Brooklyn Manhattan Transit Co. and the Independent System. In this position he has charge of all the power stations in the system which have a combined generator capacity of 600,000 kw and produce over 1,600,000,000 kwhr of electric power per year.

All patents and formula pertaining to the Lubraloy Process of Self-Lubricating Packing, have been acquired by the Flexrock Co., 3623 Filbert St., Philadelphia, manufacturers of flooring, water and weatherproofing, roofing and other building maintenance materials. Just as soon as new equipment can be installed, the Company will start producing the entire Lubraloy Process Packing Line, which includes a packing for every use.

A course of instruction has been prepared by Westinghouse Electric and Mfg. Co. which is designed to set forth in a clear and understandable manner how welding processes differ, how electronic control for resistance welding works, and how this method of control extensively adapts this welding process to industry. Its features are a new seven-part training course by slide sound films, lesson books, quiz book, and an instructors manual.

C. R. Riker, Supervisor, Extension Training, Westinghouse Electric and Mfg. Co., 306 Fourth Avenue, Pittsburgh, Pa., is in charge of the materials for the resistance welding control training course.

Electronic strip chart and Moist-o-Graph instruments studies have been added to free courses being conducted by the Brown School of Instrumentation, Brown Instrument Co., Philadelphia. The second of the 1944-45 courses of lectures, studies and practical laboratory instruction will start February 5 and continue until May 4.

Are you basing Power Plant Plans on a Coal that doesn't exist?

Why not let KNOWN FACTS * ...be your guide

While your new power plant is in the "dream stage", make a thorough FUEL INVESTIGATION.

The fuel study will reveal the coal which should be used as a basis for the design of new combustion equipment. If this study is not made first, it may develop that the coal you expect to use will soon be exhausted and actually won't EXIST for the full life of the plant.

Equipment designs should be sufficiently liberal to permit the use of a wide range of coals so that the new plant will not be in a "strait-jacket" requiring specialty or premium coals with limited reserves.

FAIRMONT COAL satisfies the fundamental requirements of the fuel investigation for most eastern markets, and is used as the design basis for many new and modernized steam plants. The "known facts" developed through the fuel study will be the guide for a modern plant which can burn the desired range of coal quality available, and enable the purchase of the best value for the fuel dollar during the plant's life.

We suggest that you consult the fuel engineers of the Fairmont Coal Bureau before proceeding further with your new power plant, or with the modernization of your existing equipment. You will be interested in the data contained in the Coal Reference Bulletins, which specialize in information not available from other sources.

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...can be burned efficiently and economically in any equipment properly designed for its use.

...it will be available for many years to come because of its huge reserves.

...it is available on three originating railroads.

...it usually represents "the best value for the fuel dollar" for long-range planning.

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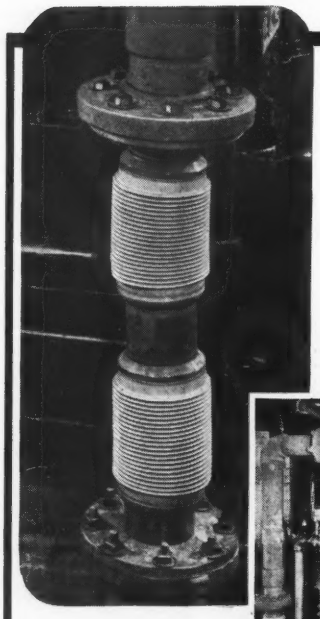

EXCESSIVE
CORROSION
+
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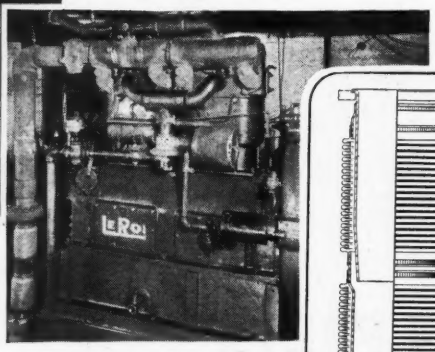

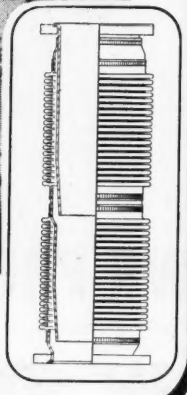

demand

REX-FLEX Stainless
Steel-lined exhaust units

Excessive heat, corrosion and vibration require an exhaust unit that is *durable.* Gas engines, especially, demand a Rex-Flex lined exhaust unit to best withstand these destructive forces.

A Rex-Flex *stainless-steel* unit was used in the above installation, since ordinary steel is more readily affected by corrosive action—caused by acidulated condensation during shut-down periods. Through the use of a lined Rex-Flex exhaust unit, a smooth bore flow was obtained—undesirable back pressures were avoided and longer unit life was assured. Flexibility was increased also, due to the Rex-Flex method of attaching the liner, which allows complete freedom of axial and radial motion within specified limits.

No matter what your exhaust connector needs are—now or in the future—you can increase operating life and efficiency with Rex-Flex Stainless-Steel lined exhaust units. Send your installation requirements to our Engineering Department—now.

Flexible Metal Hose for Every Industrial Use

CHICAGO METAL HOSE CORPORATION
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Plants: Maywood and Elgin, Ill.

The new course will include instruction in millivoltmeter type pyrometers, mechanical and continuous balance electronic potentiometers, electrically operated automatic control, flow meters, thermometers, pressure gages, hygrometers, air operated automatic controls, CO_2 and Analygraphs, and resistance thermometers and tachometers.

MANUFACTURERS' *Personals*

R. H. Luebbe, assistant manager of the Appliance and Merchandise Department in charge of legal matters and previously assistant general counsel of the General Electric Co., has been elected a vice president and general counsel of the company, succeeding the late Darious E. Peck. The retirement of Joseph E. Kewley, as vice president and general manager of the Lamp Department at Nela Park, Cleveland, has been announced. He will be succeeded by M. L. Sloan as vice president. In his capacity as vice president, Mr. Sloan will become general manager of the department.

H. S. McPherson of St. Louis has been appointed midwestern sales manager of the mechanical goods division of the United States Rubber Co., and W. M. Ballew of Kansas City, Mo., has been shifted to the post of southwestern sales manager. Mr. Ballew will be responsible for mechanical goods sales in branch offices in Kansas City, Tulsa, Denver, Houston, Dallas, New Orleans, Omaha and Minneapolis. Mr. McPherson's territory includes Detroit, Cincinnati, Indianapolis, Chicago, Milwaukee and St. Louis.

Murphy and Dickey, 537 S. Dearborn Street, Chicago 5, Ill., have been appointed sales representatives of the Ranarex Division of The Permutit Co., for Northern Illinois and bordering counties in Indiana and Iowa.

Four new appointments in General Electric Co.'s Meter and Instrument Division as recently announced are: Richard Cutts, Jr., Manager Sales, Meter Section; E. J. Wehrle, Manager Sales, and R. H. Mitchell, Assistant Manager Sales, Electric Instrument Section; and E. J. Boland, Manager Sales, Aircraft Instrument Section. The four men will be located at the West Lynn Works.

Clinton R. Hanna, inventor of the tank-gun stabilizer which enables Allied tanks to fire accurately while in motion, has been appointed an associate director of the Westinghouse Research Laboratories it was announced by Dr. L. W. Chubb, Director of Research. Mr. Hanna, who is also manager of the electro-mechanical department of the Research Laboratories, has been associated with Westinghouse since 1922 in the development of new apparatus, and he has inventions covered by more than 80 patents in the United States and foreign countries. For his work in the development of the tank-gun stabilizer, he was awarded a Presidential Citation in 1942.

Archibald J. Cooper has been appointed manager of the Allis-Chalmers Manufacturing Co.'s New York district office. He was formerly assistant man-

COCHRANE Deaeration SAVES!

Deaeration of boiler feedwater is one of the big items of economy in power plant operation.

Cochrane Deaerators of varying sizes, designs and construction have been protecting the boiler plants of industry for many years. The feed piping, economizers, water walls and tubes of these boilers are effectively protected by Cochrane Deaeration, which removes both dissolved oxygen and soluble gases, and at the same time produces savings in heat and fuel by heating the water to the boiling point.

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COCHRANE

SOFTENERS · DEAERATING SOFTENERS · DEAERATORS · METERS · STEAM SPECIALTIES

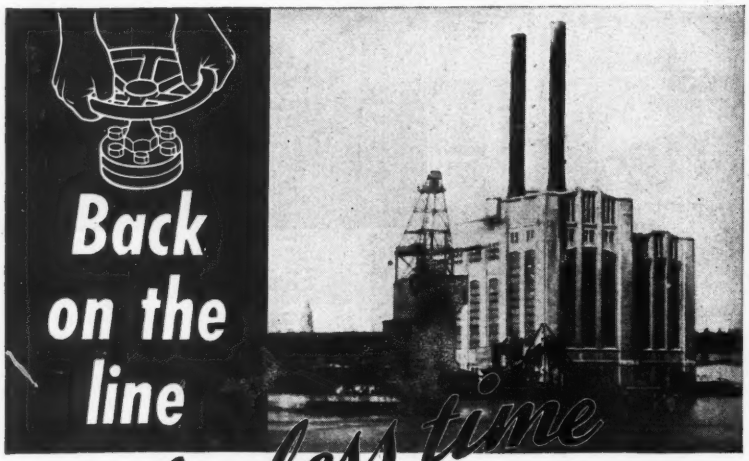
ager of the New York office and now succeeds A. F. Rolf, who will devote full time to his duties as assistant secretary of the company.

Allis-Chalmers Manufacturing Co., Milwaukee 1, Wis., has announced the appointment of Jay C. Warner to assist in the development of the company's sales in the Far East, Australia and New Zealand.

The Swartwout Co., Cleveland, Ohio, has appointed Royal L. Meyer as Chief Engineer and Assistant Manager of their Steam Division. Mr. Meyer, recently a partner of Vern E. Alden, Chicago consulting engineer, spent 18 years with Standard Oil Co. of Indiana in power plant work. He was superintendent of utilities for this concern for 10 years, in charge of the generation of steam and electricity, the maintenance of meters and controls and the compression of air and pumping of water. His earlier responsibilities included supervision of power plant design and construction. Prior experience included connections with Sargent & Lundy, Inc., Chicago consulting engineers; Wisconsin Traction, Light, Heat and Power Co. at Appleton, Wis.; and Kimberly-Clark Co., Neenah, Wis., paper manufacturers.

Earl L. Wiseman, manager of the Ventilator Division of The Swartwout Co., Cleveland, Ohio, has been named vice president. Mr. Wiseman was made manager of the division in 1943 and has been sales manager for eight years.

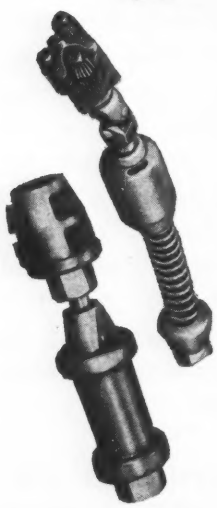
Charles C. Bray has been appointed Assistant to the Manager of the Worm Gear Division of the De Laval Steam Turbine Co. Prior to accepting this position, he served as a metallurgist for the special steel department of the Philadelphia office of Joseph T. Ryerson & Sons. Mr. Bray had previously served for ten years as a worm gear sales engineer in the De Laval Chicago Office before joining the Ryerson organization.



Production losses due to unnecessarily long down-time of your boilers can be eliminated—with Wilson Tube Cleaners.

The high torque and extra power, together with the non-stalling characteristics of the Wilson E. P. and E. C. T. Series Air Motors, make possible fast, easy removal of all types of deposits in straight or curved tubes of boilers and other large bore tubular equipment. Moreover, automatic valving of the operating air, exclusive with Wilson, reduces air consumption to a minimum.

Thomas C. Wilson, Inc. maintains a large engineering staff to help you solve your tube cleaning problems. A copy of the Wilson Tube Cleaner's Check List and a 40-page bulletin describing the complete line of Wilson Tube Cleaners will be sent on request.



Wilson Tube Cleaners for straight and curved boiler tubes

wilson

THOMAS C. WILSON Inc.
21 11 44th AVENUE, LONG ISLAND CITY 1, NEW YORK

NEWS *from* THE FIELD

Changes in Stone & Webster Organization

STONE & WEBSTER ENGINEERING CORP. has elected Russell T. Branch President of the Corporation to succeed John R. Lotz, who was elected Chairman of the Board after serving eight years as President. Mr. Branch's election to the presidency follows more than thirty years of service with the Stone & Webster organization during which period he has been successively Superintendent of Construction, Construction Manager, Vice President and Senior Construction Manager, and Executive Vice President.

Mr. Lotz, under whose guidance the organization has successfully executed an unprecedented volume of work, will continue to have an active part in the affairs of the Corporation.

The Board of Directors also announces the election of Emmart LaCrosse as Vice Chairman of the Board, Joseph Pope as First Vice President, and Karl Finsterbusch, H. E. Brailey, R. E. Argersinger and H. L. Bunce, Jr., as Vice Presidents of the Corporation.

New Jersey Corp. to Spend $15,000,000

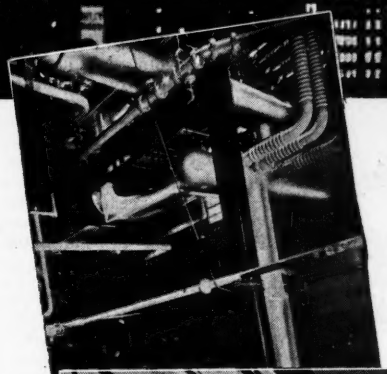
PUBLIC SERVICE CORP. of New Jersey has authorized a construction budget for 1945 of more than $15,000,000 for new equipment, extensions and replacements for its subsidiary operating companies.

Of the total amount, $4,655,807 is for the electric department and $3,740,460 for the gas department of Public Service Electric & Gas Co.; $4,114,300 for Public Service Coordinated Transport and $2,159,600 for Public Service Interstate Transportation Co. The system gas companies of the Corporation—Atlantic City Gas Co., Peoples Gas Co. and County Gas Co.—are allotted approximately $350,000.

Lubrication Engineers Organize

LUBRICATION ENGINEERS representing prominent industrial and transportation companies and educators have organized a non-profit body known as the American Society of Lubrication Engineers, with headquarters at 135 South LaSalle Street, Chicago. Their stated objective is to put on a sound basis the fundamental precepts of lubrication, which are believed to be of benefit to all phases of industry with their many related problems.

Membership is stated to consist of representatives of the educational field, machinery builders, lubricant suppliers



THE Kellogg Scientific Method of solving tough piping problems has enabled central stations, process and marine power plants to successfully meet wartime emergency needs.

Kellogg prefabricated piping systems simplify piping problems because they conserve space—minimize joint stresses—provide safe connections to equipment unable to stand high forces or moments due to expansion—and give flexibility and complete reliability.

Consulting engineers, power process and marine engineers recognize the Kellogg trade mark as a symbol of scientifically designed piping.

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Pressure Vessels · Refinement Piping Systems · Industrial Plants for Power, Refinery and Chemical Industries. Heat Exchangers. Pyrolytic and Catalytic Cracking Units, Hydroforming, Reforming, Dehydrogenation, Alkylation, Desulphurization. Thermal and Catalytic Polymerization Units · Jessel Processes for Lubricating Oil Plants. Plastic Refractories · Radial Brick Chimneys.

THE M. W. KELLOGG COMPANY · JERSEY CITY, NEW JERSEY · 225 BROADWAY, NEW YORK 7, N. Y.

LOS ANGELES · 609 SOUTH GRAND — REPRESENTATIVES — TULSA · PHILTOWER BLDG.

and consumers as represented by the various phases of industry. The further aim will be "to promote the subject of lubrication in the various educational institutions to better prepare future members of industry for a more complete understanding of the operational problems to follow."

Officers of the American Society of Lubrication Engineers are: C. E. Pritchard, Republic Steel Co., president; J. C. Peebles, Dean of Engineering, Illinois Institute of Technology, vice-president; H. B. Jennings, Professor of Mechanical Engineering, Northwestern University, secretary and treasurer. Directors include D. N. Evans, Inland Steel Co.; I. L. Harper, Lehigh Valley Railroad; and D. E. Whitehead, Carnegie-Illinois Steel Co.

Electric Light and Power Industry in 1944

IN A YEAR-END review of the electric light and power industry for 1944, C. W. Kellogg, President of the Edison Electric Institute, stated that electric power has successfully met the peak demand resulting from America's war effort and the year 1944 has once more made an all-time record in production, sales and revenues for the electric power industry. As in previous years, full service has been maintained to all customers, military and civilian.

Eighty per cent of this power output was produced by electric companies, servicing the mining and manufacturing centers of America.

Because of restrictions in the use of materials, construction expenditures were the lowest in ten years. Accruals for depreciation were considerably in excess of the money actually spent for replacements and no new capital was raised by the sale of securities during the year.

The principal line extensions during the year were in farm areas to serve food producing farms as defined by the War Production Board. Over half of America's farms now have electricity and electric companies serve two-thirds of these electrified farms.

Installed capacity of all electric utility power plants, both public and private, increased during the year by about 1,500,000 kw, bringing the total at the present time to about 50,500,000. Since the beginning of the war in Europe in the summer of 1939, generating capacity has grown by 11,000,000 kw.

Output of electricity in 1944, by all agencies contributing to the public supply, totaled approximately 230 billion kwhr, an increase of 9 billion, or 4 per cent, over the production in 1943.

In addition to the production of electricity by public utility plants, approximately 53 billion kwhr were generated by industrial plants for their own use, bringing the total of all electricity generated for all purposes in the United States in 1944 to 283 billion. Also some 2 billion kwhr more were imported from Canada.

The large expansion of electrometals—aluminum, magnesium, electric-steels and ferro-alloys—which constituted a striking feature of the increase in sales of electricity during the two previous years, slacked off in 1944. The curtailment of electric steels, the shutdown of aluminum plants operating on fuel-generated power and the complete stoppage of the manufacture of magnesium, contributed largely to the decline in power sales during the last four months of 1944.

In 1944 the electric utility companies of the United States spent in round numbers 200 million dollars for construction purposes. Because of the uncertainty as to the length of the war and the release of construction materials, it is difficult to estimate construction expenditures in 1945. If the restrictions continue throughout the year 1945, the total for next year will fall below 1944. Indications are, however, that construction expenditures in the year following the removal of restrictions will be from 250 to 300 million dollars. Plans for rural extensions, for one thing, contemplate an expenditure of 80 million dollars in the first year after restrictions are removed.

NAFM Officers

THE FOLLOWING officers were elected for the ensuing year at the Twenty-Eighth Annual Meeting of the National Association of Fan Manufacturers held at Hot Springs, Virginia, on January 12, 1945. R. H. Nelson, President; C. T. Morse, Vice-President; and L. O. Monroe, Secretary-Treasurer.

Mr. Nelson is President of The Herman Nelson Corp., Moline, Ill., and Mr. Morse is President of the American Blower Corp., Detroit, Mich.

Jacket Cooling Water Problems

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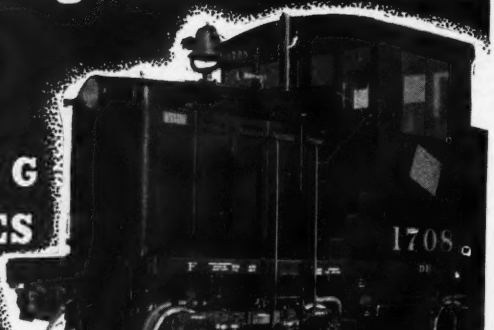

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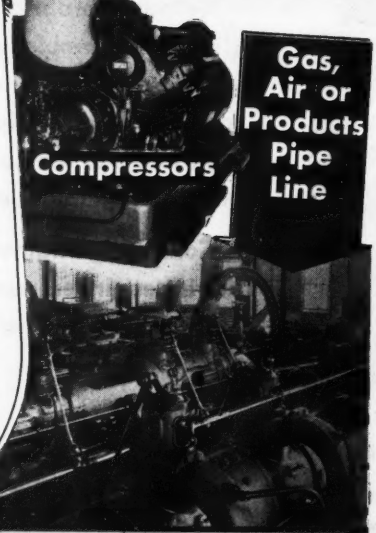

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Strength-Ductility

...AND ITS OVERALL IMPORTANCE IN AN ENGINEERING METAL

In general terms, ductility is the property of a metal that permits it to be deformed without fracture.

It is the exact opposite of brittleness.

If two materials have the same strength and hardness, the one with greater ductility has a good chance of holding up under overloads which would snap the other.

Thus, ductility is especially important in bolts, where strain is likely to result from too vigorous tightening or from abrupt temperature changes. It also is an essential property in metal gaskets. A strong, ductile gasket will adapt itself readily to imperfections in joint surfaces while maintaining the strength necessary to prevent leakage.

And, finally, high ductility is a great advantage in fabrication. The more ductile the material, the more easily it can be handled by the usual cold-working methods... bending, deep drawing, spinning, cold heading.

Strength and Ductility

By the very nature of materials, strength and ductility are divergent properties. As one increases the other decreases. As a general rule, highly ductile metals are soft and weak; some high strength metals are hard and comparatively brittle. But one of the outstanding characteristics of INCO Nickel Alloys is their exceptional combination of strength with high ductility.

How Ductility is measured

There are several methods for testing the ductility of metals, but the most common method is to pull a specimen of the metal on a tensile testing machine until it breaks. The ductility of the metal is then determined by measuring how much the specimen "stretched" or elongated.

This is the method which was used in measuring the strength-ductility of Monel and other metals as shown in the charts below.

What the charts show

In Fig. 1, showing tests made by R. L. Templin and R. G. Sturm, the top point of the curve indicates the tensile strength of the various metals. Ductility... as evidenced by the metal's "stretch"... is shown by the horizontal carry of the curve to the point where it drops off sharply.

Fig. 2 shows the results of strength-ductility tests with ⅜" diameter bolts of Monel, brass, bronze and steel, as determined at Columbia University, New York City. This test shows the high value of Monel for bolts and similar applications.

Spun Monel diaphragms

Stronger than mild steel, Monel is ductile enough to be formed in the most severe of all metal working methods... spinning.

Diaphragms for gas meters and gas analysis instruments are spun from Monel, as illustrated in the accompanying photo.

Ductility makes the spinning process easier... the combined strength, hardness and corrosion resistance mean longer life for the finished Monel part.

TENSILE STRENGTH-DUCTILITY CURVES
FOR SOME METALS AND ALLOYS

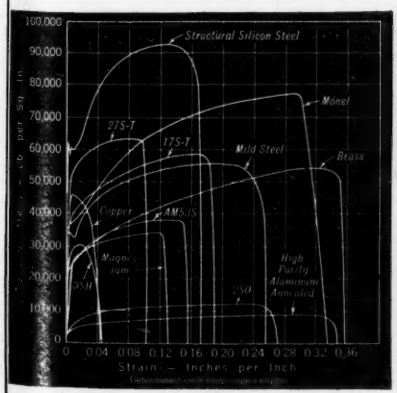


FIG. 1

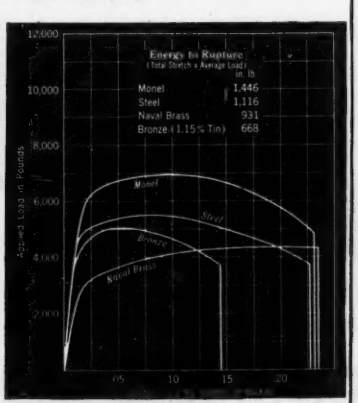
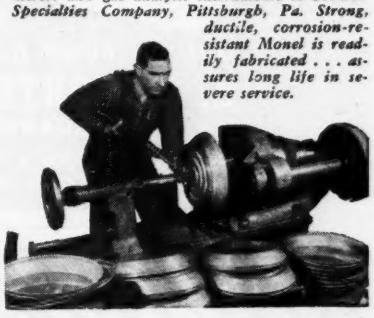


FIG. 2

HIGH-TEMPERATURE HIGH-PRESSURE STEAM *line gaskets formed from Monel by Goetze Gasket & Packing Co. Combined strength-ductility of Monel permits thinner gaskets, saving stress on bolts. Monel gaskets adapt self to joint surfaces... assure strong, tight, lasting seal.*

SPINNING MONEL DIAPHRAGMS *for gas meters and gas analysis instruments at Schwab Specialties Company, Pittsburgh, Pa. Strong, ductile, corrosion-resistant Monel is readily fabricated... assures long life in severe service.*



Gaskets for high temperatures

Typical Monel gaskets for lines carrying steam at high pressures and at temperatures over 500° F. are illustrated also. Since Monel is stronger at 1000° F. than mild steel is at room temperature, thinner and narrower gaskets can be used. Thus, stresses on flange bolts can be reduced considerably. Yet, despite its strength, Monel is so ductile that a gasket shapes itself to slight imperfections in the flange faces as the bolts are tightened, forming a sealed joint that stays tight at high pressures. Alternate heating and cooling do not embrittle Monel gaskets... ductility remains at a high level.

• • •

For further information about ductility and other properties of metals, write for the booklet, "The Technical Editor Speaks." A copy is yours for the asking. Address:

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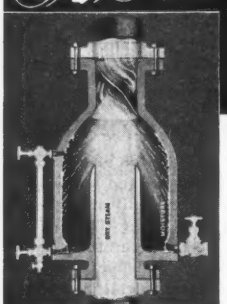

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New ENGINEERING BOOKS

Fields and Waves in Modern Radio. By Simon Ramo and John R. Whinnery. First edition, 502 pages, 6 by 8½ in., cloth, illustrated. Published by John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1944. Price $5.00.

This book is concerned with certain aspects of electromagnetic theory in their relation to the problems of modern radio and electronics engineering. As pointed out by the authors, when this book was begun several years ago, there was no book which even approximately filled the very apparent need for an extensive treatment of field and wave theory from the radio engineer's point of view; all the needed information was distributed widely throughout electrical literature. Since that time several excellent books have appeared, each of which has filled a part of that need, yet in the present volume the purpose, order of presentation, choice of material, and emphasis are different enough from those of the others so that it is not a duplication of these.

The material presented in this book was first used in courses given at the General Electric Co. to student engineers. The authors had occasion to use essentially all of the material in this book in their engineering analysis and laboratory work, in addition to trying to understand it from a slightly different point of view necessary for presentation in classes to other student engineers.

Specifically, the most important objectives were the treatments of high-frequency circuits, skin effect, and shielding problems, problems of wave transmission and reflection, transmission lines and wave guides, cavity resonators, and antennas and other radiating systems, given in the latter two-thirds of the book.

The book is not particularly simple and is not intended for practical engineers who have not had considerable ground work in mathematics. The book is designed for students and electrical engineers who have had the usual engineering mathematics courses through the calculus, but not necessarily any additional subjects such as vector analysis or extensive courses in differential equations.

The first chapter is introduced to bridge certain gaps; in mathematics, between basic calculus and some of the mathematical tools required for the study of field and wave theory; in concept, between straightforward application of Kirchhoff's laws and the approximations and defined quantities of high-frequency circuits and transmission line problems. Elementary differential equation solutions, the Fourier series, and the use of complex exponentials are thus introduced with circuit and transmission line problems as oscillation and wave examples.

The authors are both in the Electronics Laboratory of the General Electric Co. and this book is one of a series writtten in the interest of the General Electric Company's Advanced Engineering Program.

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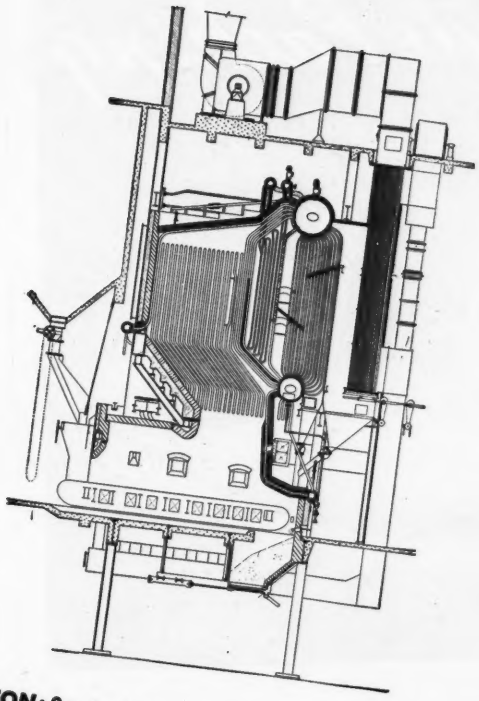

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DRUM PRESSURE	450 psi.
DEGREES OF SUPERHEAT	300
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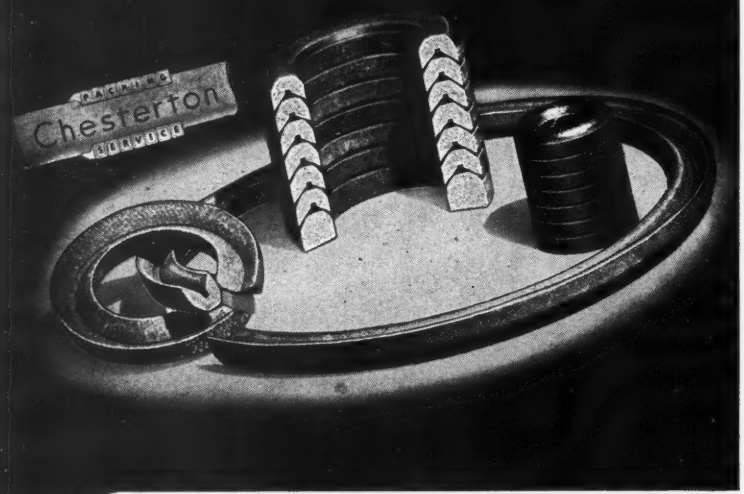

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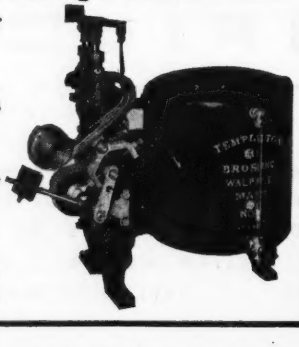

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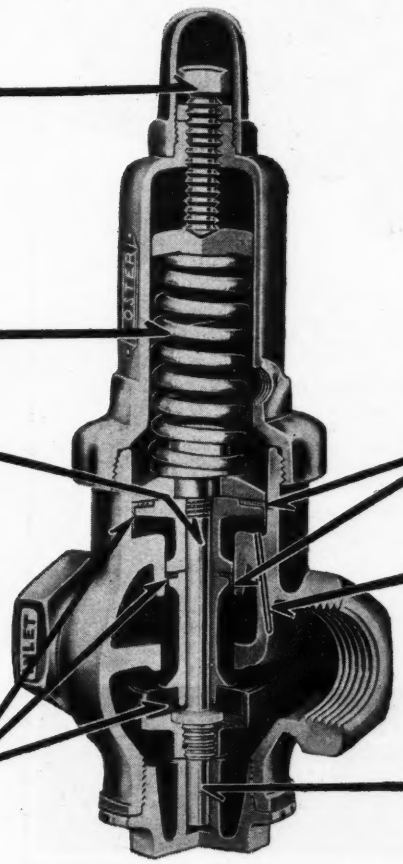

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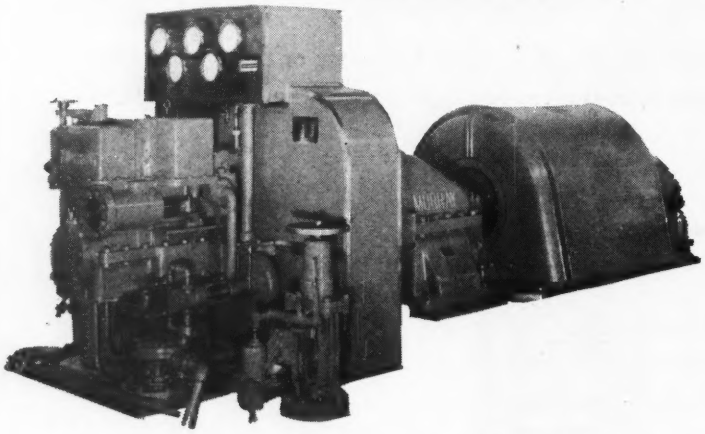

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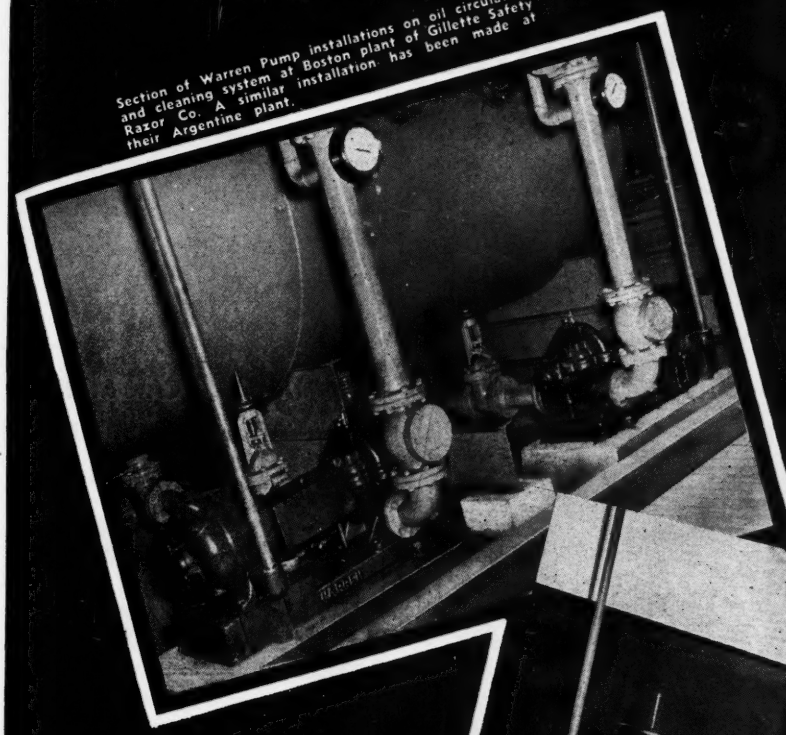

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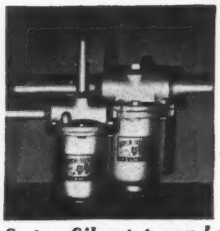

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HOW TO CHOOSE
A STEAM TRAP

● The National Fuel Efficiency Program, in cooperation with the Bureau of Mines, has recently published a Fuel Waste Chasers quiz. This quiz deals with the efficient use of Steam Traps to save fuel. It asks many pertinent questions about their use. The answers to these and many more questions concerning the efficient use of Steam Traps, plus a description of Super-Silvertops . . . the most economical trap for draining condensate . . . are found in the book, "How To Choose A Steam Trap," which is yours upon request.

THE V. D. ANDERSON COMPANY
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ALLPAX

THE PACKING THAT "PACKS ALL"

. . . use it once and
. . . you'll use it always

Here's the universal packing that can be used for any fluid or on any apparatus—economically, efficiently—tightly—simply.

Try ALLPAX and you, too, will be enthusiastic over its easy application and long wear. You don't have to remove old packing to repack with ALLPAX. Square cross section makes ALLPAX easy-filling in any stuffing box.

Try it and you'll always use it. Full details on request.

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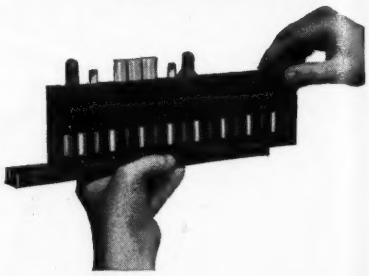
Distributors Everywhere

Keep Tab with a Miniature Lab



You CAN MAKE ACCURATE, SPEEDY DETERMINATIONS OF pH and PHOSPHATE IN 3 EASY STEPS WITH TAYLOR COMPARATORS

pH in 60 seconds
phosphate in 2 minutes

FREE BOOKLET

Describes modern scientific outfits (priced as low as $19.00), and improved methods employed by industry to step up boiler efficiency and prevent damage to equipment caused by scale, corrosion and embrittlement. Accuracy is Assured for ALL Taylor Liquid Color Standards Carry An UNLIMITED GUARANTEE AGAINST FADING.

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WHEN YOU USE R/M, you can pack up your packing troubles for keeps. . . . R/M makes 73 different types of packing, each in a number of different sizes . . . rings, spirals, wicks, coils, sheets, spools, tubes, gaskets, bulk . . . packing for pumps, valves, compressors, flanges, hydraulic cylinders, steam engines, man-holes, all industrial uses . . . for temperatures to 1200° F. . . . for pressures to 5,000 pounds . . . a complete, reliable, time-tested line . . . and all one quality. . . . Specify R/M packings now at your distributor's. It's "PACKED WITH SATISFACTION"—WHEN YOU USE R/M.

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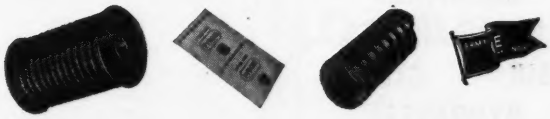

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INCORPORATED

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STOP
wasting manpower in the boiler plant

● Here is a clean, automatic system of both coal and ash handling that is complete. Beaumont engineers take full responsibility from design to finished structure including all necessary equipment for handling coal from car to stoker and ashes from pit to truck.

The entire system is designed and built to individual requirements, at reasonable cost. Full details on Beaumont products and materials-handling systems upon request.

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DESIGNERS • MANUFACTURERS • ERECTORS OF COAL AND ASH HANDLING SYSTEMS

Consult Us For:
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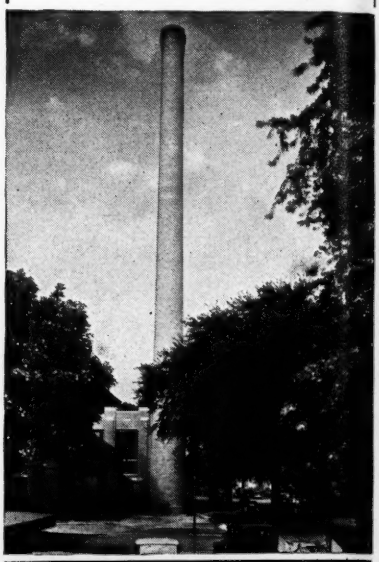
FURNACE WORK .
BOILER SETTINGS



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for
Low Cost Leakproof Handling of
OILS • GASES
CHEMICALS
REFRIGERANTS
AIR • STEAM
HYDRAULIC
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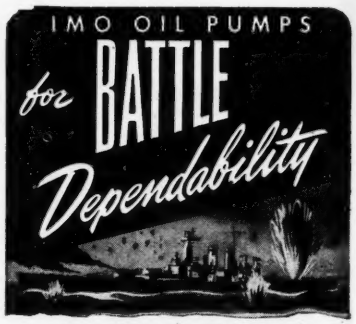
Also
DIESEL EXHAUSTS

METAL HOSE

ITS deep, parallel sidewall corrugations combine maximum flexibility with lasting toughness—makes Eclipse Flexible Metal Hose the logical low-cost material for Diesel exhausts and for handling all kinds of liquids or gases where vibration and expansion are present . . . Eclipse Metal Hose withstands high pressure and temperatures. Monel hose is stocked in sizes ¼ in. to 2 in. I.D.; steel hose can be produced up to 40 in. I.D. Write us about your problems of conveying non-solids, non-abrasives. Ask for latest descriptive bulletin.

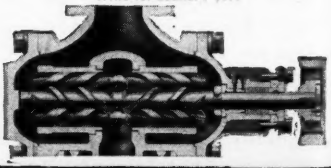
THE INVISIBLE CREW
Precision Equipment by **Bendix** AVIATION CORPORATION
Dept. 19—Phila. Div.—Philadelphia, Pa.

IMO OIL PUMPS
for **BATTLE** *Dependability*

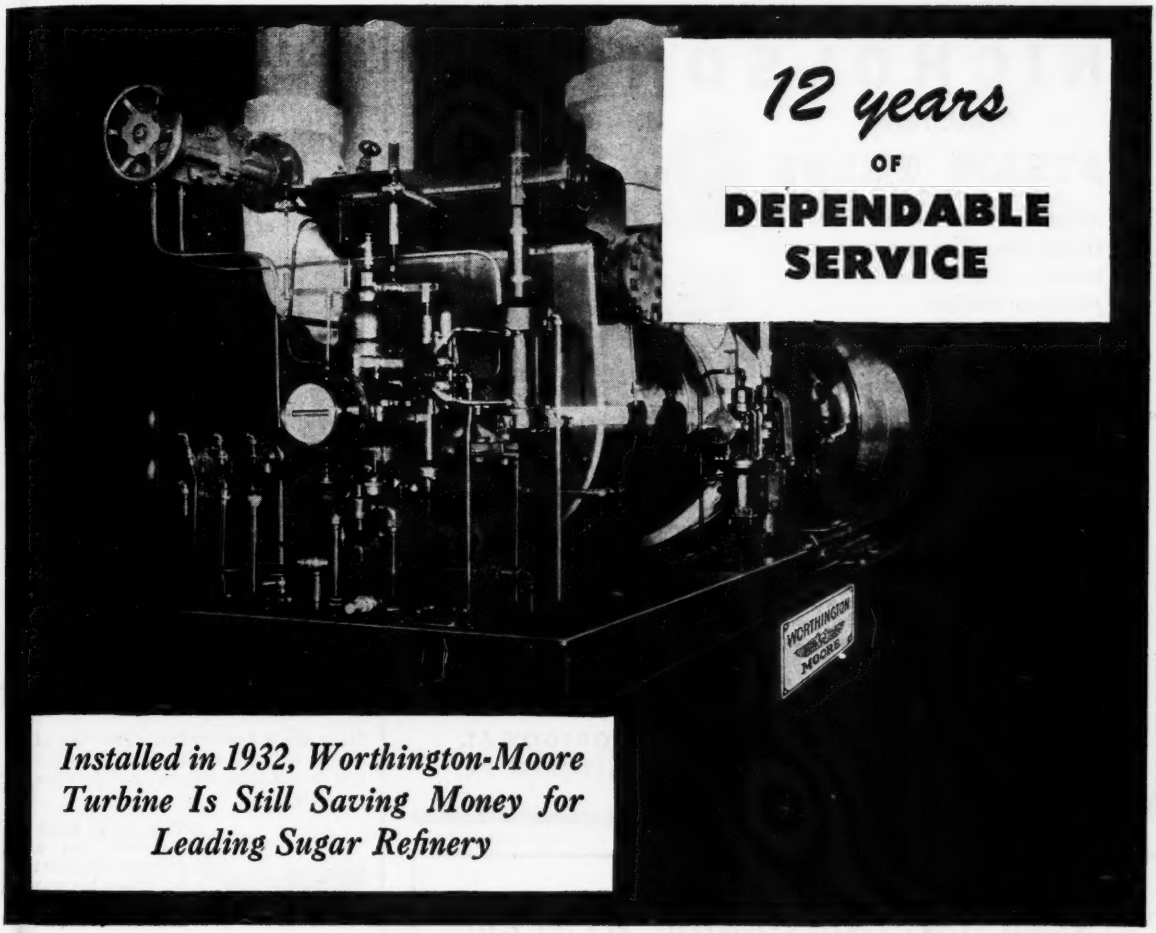


A cruiser of the U. S. Navy, one of the classes of ships equipped with De Laval-IMO oil pumps

On fighting ships, where reliability and dependability under strain are all important and where space is at a premium, many thousand IMO oil pumps are in use pumping fuel oil, circulating lubricating oils, and operating hydraulic machinery. The simplicity of construction and operation that makes the IMO pump so dependable in battle assures the commercial user of long life and trouble-free operation. This unique pump has practically nothing to get out of order; it has only three moving parts, and no pilot gears or valves.
Write for Leaflet I-117.



IMO PUMP DIVISION
of the De Laval Steam Turbine Company
Trenton 2, New Jersey



Installed in 1932, Worthington-Moore Turbine Is Still Saving Money for Leading Sugar Refinery

Dan Gutleben, engineer for the Pennsylvania Sugar Company, recently wrote: "Our Worthington-Moore turbine rolls along every day and every night without stopping. It ran for years with very few shut-downs and no service expense whatever."

Electricity a By-product

This 2000 KW turbine-generator, like many other Worthington-Moore units, produces low-cost electricity as a by-product. It operates on steam at 400 lbs. pressure, 500°F. total temperature, 12 lbs. back pressure and automatically extracts steam at 90 lbs.

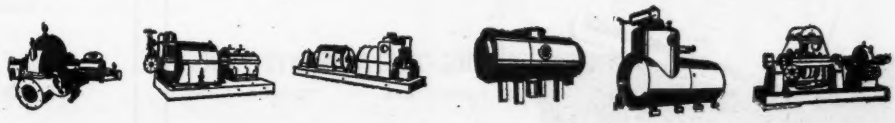
Engineering the Right Turbine for the Job

Experienced in special turbine applications, as well as in a wide range of related steam power plant equipment, Worthington-Moore engineers are especially fitted to recommend the best type of unit for your particular requirements. *Worthington Pump and Machinery Corporation, Moore Steam Turbine Division, Wellsville, New York.*

BEHIND THE NAME
WORTHINGTON
MOORE

MR44

A GREAT TEAM IN STEAM

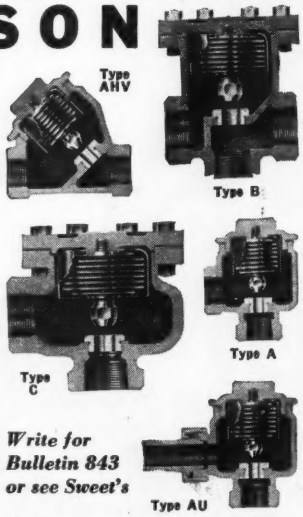


NICHOLSON

INDUSTRIAL

STEAM TRAPS

discharge air and wet steam as efficiently as water . . . with quick positive action



Better Circulation of Steam, More Rapid Transfer of Heat

Write for Bulletin 843 or see Sweet's

This is only one of the features that make Nicholson Industrial Steam Traps lead in their field. Consider these other advantages:

NO FREEZE-UPS—Drain completely when cold, hence cannot freeze.

NO ADJUSTMENT—Same size valve and seat for any pressure from vacuum up to the maximum allowable with construction used.

NO DRIBBLING—Closes immediately when steam contacts bellows.

NO WATER-LOGGED UNITS—Requires but a few degrees temperature differential to open valve.

OTHER NICHOLSON PRODUCTS: Piston and Weight-Operated Steam Traps; Compressed Air and Gasoline Traps; Flexible and Compression Shaft Couplings; Expanding Mandrels; Arbor Presses; Steam Eliminators and Separators.

W. H. NICHOLSON & CO. 160 OREGON ST. WILKES-BARRE, PA.

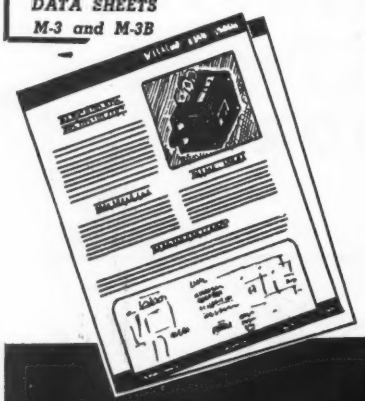
VIKING ENGINE ALARM SYSTEMS

GUARD AGAINST ENGINE BREAKDOWN

FROM:

1. EXCESSIVE TEMPERATURE OF CIRCULATING-WATER SYSTEM
2. INSUFFICIENT PRESSURE IN LUBRICATING-OIL SYSTEM

WRITE FOR DATA SHEETS M-3 and M-3B

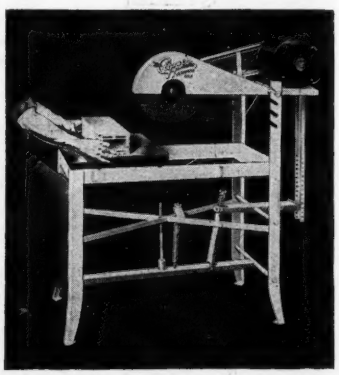


Every diesel and gas engine should be properly protected with a Viking alarm system. Viking is a *complete system*, no extras to buy. When water temperature becomes too high or oil-pressure too low, howler sounds to warn operator of danger. Type M-3B provides visual indication of source of trouble, also Heavy-duty construction, factory-set for your own requirements.

VIKING INSTRUMENTS, INC.
403 Fairfield Ave. Stamford, Conn.

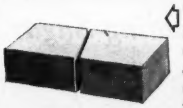
FASTER CUTTING ...with Clipper Masonry Saws

Your Special Size and Shape Brick or Tile can now be "Tailor-Made" at a moment's notice!



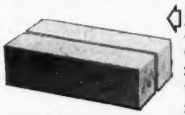
The new Clipper Multiple Cutting Principle makes possible faster cutting of every masonry material regardless of hardness.

Here are a few typical examples of the speed and accuracy with which fire brick can be cut for furnace repairs.



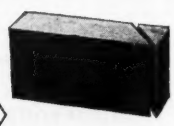
This acid brick intended for a chemical plant acid chamber was cut completely in two, in 37 sec.

One of many intricate cuts performed on first quality clay brick for heat treating furnaces. Made in 8 seconds.



Silica brick cut lengthwise for open hearth furnace work, only 9 seconds were required to complete this cut!

Basic refractories for steel furnaces or cement kilns must be accurately installed. This magnesite brick was cut in 12 seconds!



Clipper Saws are available for trial. Write for Descriptive Catalogs.

THE Clipper "CUTS RIGHT THRU" MANUFACTURING COMPANY

4018 MANCHESTER
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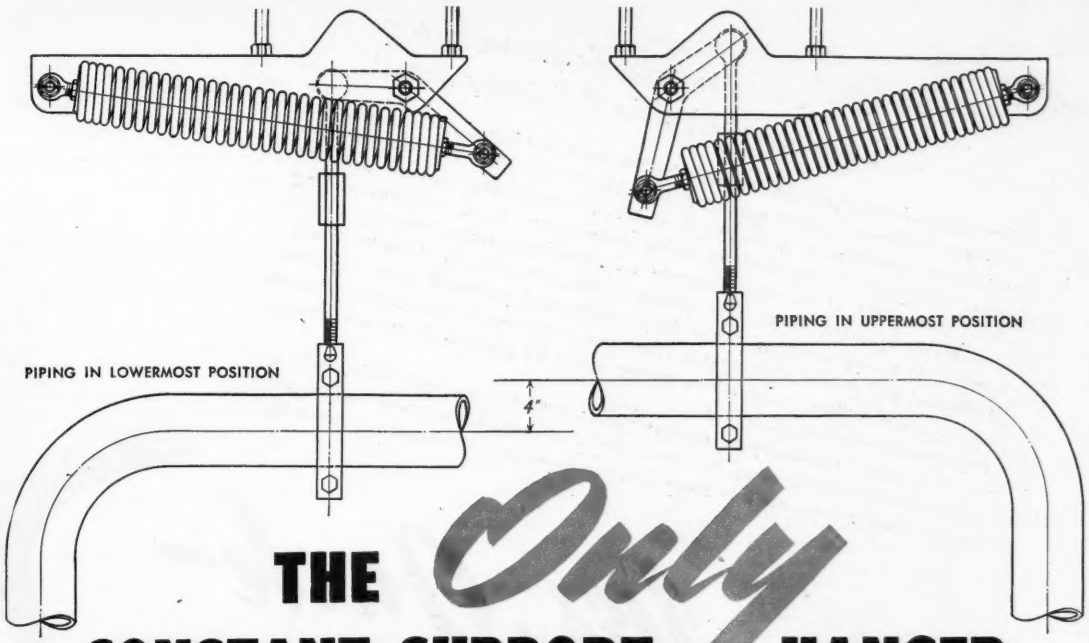
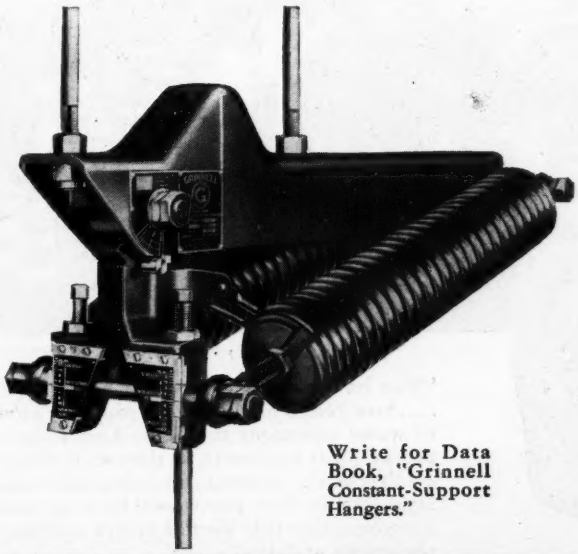


THE *Only* CONSTANT-SUPPORT HANGER

WITH GRINNELL CONSTANT-SUPPORT HANGERS, weight transfer stresses are completely eliminated throughout the entire range of vertical movement. In operation the lever, turning on the main pivot, balances the weight of a vertically shifting load. The change in moment arm with lever rotation is such that the product of the moment arm and the spring force is always constant and equal to the weight of the piping system.



Write for Data Book, "Grinnell Constant-Support Hangers."

EXCLUSIVE FEATURES OF GRINNELL CONSTANT-SUPPORT HANGERS

Constant-support of piping in all "hot" and "cold" positions.

Full safety factor of the supported system is always maintained.

Non-resonant and energy absorbing.

Mass produced from standard precision parts.

Individually calibrated for each specific installation.

Load adjustment features are incorporated into the design.

3 models meet entire range of load-travel specifications.

The rated capacity of each model varies with the size of the springs used – the overall dimensions of the hanger remain constant.

Minimum head room is required.

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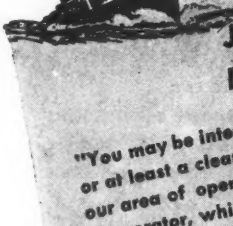
GRINNELL
WHENEVER **PIPING** IS INVOLVED



Jack, a former Nalco employee, now a Lieutenant (j. g.) in the U. S. Navy writes:

"You may be interested in knowing that water treatment has provided a brighter, or at least a cleaner, life for some 240 men aboard this ship. The sea water in our area of operation is pretty tough stuff . . . consequently our low pressure evaporator, which is used both for boiler make-up and ships use, was making about three-fifths of its rated capacity . . . this necessitated turning off the showers and basins to the crew, except for one or two hours of the 24. I managed to rig a corn starch and navy boiler compound treatment (only treatment available) and we are now making 10 percent over capacity and have the water on 24 hours a day, besides eliminating about 90 percent of the mechanical cleaning formerly necessary.

"It is hardly necessary to say that it does not compare with Nalco balls in quality or ease of handling. It is the same story which you have undoubtedly heard many a time, but it is darned nice to experience the benefits personally."

Yes, Jack—

NALCO SERVICE GETS THE JOB DONE BEST!"

. . . says H R Powers

Nalco Representative
Pittsburgh, Pa.

Photo in Nalco Laboratories

"You have seen it work many times Jack, ... how Nalco has licked the toughest kind of water treatment problem. And, today's power plant engineers, as they successfully combat scale, corrosion, pitting, foaming, algae, etc. in their plants, will back up your statement that it is *'darned nice to experience the benefits of Nalco! . . . ."*

We are ready to prove what *Nalco—the complete water treating service*—can mean to you and your plant. Call Nalco today!

NATIONAL ALUMINATE CORPORATION

6224 West 66th Place • Chicago 38, Illinois

Canadian inquiries should be addressed to Aluminate Chemicals, Ltd., 555 Eastern Ave., Toronto, Ontario

Nalco

System of Scientific Water Treating Sevice . . . for all industry

HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail.

BOILER PLANT

1 Steel Encased, Insulated Boiler—New 28-pg bulletin shows sectional views and operating advantages of Keeler Type CP steam generator. Features include: complete steel casing and insulation, water-cooled sides of furnace, built-in mechanical soot blower. Capacities to 100,000 lb per hr. E. Keeler Co.

2 AE Offers New Stoker Literature—"More Steam at Lower Cost"—an 8-pg bulletin tells about the new AE perfect spread stoker, with photographs, cross-sections and drawings. Stoker is said to burn all kinds and grades of solid fuels thoroughly, wet or dry. Completely automatic, extremely quiet operation with non-clog, variable speed feed. American Engineering Co.

3 Non-Segregating Coal Distributor—New Bulletin 45 explains construction and advantages of Conical non-segregating coal distributors. By delivering uniform mixture of coarse and fine coal across the stoker, these units insure higher average CO_2, and increase boiler rating. Stock Engineering Co.

4 Oil Burners—Bulletin No. 802 describing the Peabody Type M oil burner, has just been prepared by the Peabody Engineering Corp. Illustrates mechanical and operating features of the burner, for natural or forced draft operation and for use with mechanical, wide range mechanical or steam atomizers.

5 Water Column Data—Bulletin No. 917A describes optical principle of Diamond Bi-Color water gage which shows the water as green, the steam as red. This 48-pg booklet also shows recommended piping arrangements and other useful handbook data. Diamond Power Specialty Corp.

6 Radiant Type Boiler—Bulletin RB describes a patented 4-drum boiler design that is said to double the usual radiant exposure found in 4-drum boilers. This feature provides faster steaming capacity, lower furnace temperatures and maintenance, lower setting costs. Union Iron Works.

7 Adjustable Water Gages—New 8-pg folder describes Ernst split-gland adjustable water gages, clear-through vision glass inserts and other boiler fittings. Ernst Water Column & Gage Co.

ELECTRICAL

8 Pyranol Capacitors—"Engineering Aspects of Pyranol Capacitors in Large Banks" is the title of new 20-pg Bulletin GEA-4225. Covers basic principles of system kvar requirements, application problems, installation data. General Electric Co.

9 Electrically Operated Switches—Described in 16-pg Bulletin No. 600 are Asco automatic transfer switches, remote control switches, contactors and relays. Contains wiring diagrams, operating details and other data useful to operating and maintenance men. Automatic Switch Co.

10 Motor Maintenance Handbook—"Hints to Make Motors Last" is the title of handy little booklet for engineers and maintenance men. Check chart tells what to do when motor fails to start, runs hot, is noisy, shows excessive brush wear, etc. Westinghouse Electric & Mfg. Co.

11 Radar Masts and Towers—New Harco catalog describing nine different types of masts and towers, from 20 to 500 ft high, the shortest of which can be erected by one man in fifteen minutes. Featured is the rigid "Bantam King," lending itself particularly to radar and to such applications as may require 500 or more pounds of top loading on an 8x4 ft platform. Harco Steel Construction Co., Inc.

12 X-Ray for Identification—New 12-pg booklet that describes X-ray diffraction techniques and applications has been announced by North American Philips Co. Diagrams, typical diffraction films, and several tabulations are given in order to show how Norelco X-ray diffraction equipment is used for identification, research and production. It catalogs specific problems that can be handled in the following fields: Alloys, asbestos, carbon, case hardening, cellulose, cement, cold-rolled steel, dry cells and batteries, electric silicon steel, steel forming, greases, paper and parchment, plastic film, rayon, resin, resistance alloys, rubber, textiles, tungsten, etc.

FANS, PUMPS, COMPRESSORS

13 Facts About Rotary Pumps—This is a revision of a previous Blackmer bulletin of the same title numbered 304. Drawing shows the portion of a bucket (swinging vane) that can wear away without affecting the capacity of a Blackmer pump and the simplified diagrams illustrate its operating cycle. Blackmer Pump Co.

14 Industrial Pump Handbook—104-pg catalog describes the Bump Pump principle of operation, range of sizes in both industrial and sanitary pumps. Contains operating and construction features, emphasized with cutaway views of different models, dimension and installation diagrams, horsepower charts, equivalent, and friction loss tables. Materials recommended for pumping various liquids, together with typical installations, and plant views. Bump Pump Co.

15 Compressed Air Handbook—New 24-pg two-color booklet entitled, "A Little Air Power Will Do Many a Big Job" contains useful handbook data. Nearly 70 photographs show how to use compressed air for starting engines, spraying paint or insulation, metallizing, driving pumps and doing many other jobs around the plant. Ingersoll-Rand Co.

16 Hydraulic Pumps and Pittings—Bulletin published by The Watson-Stillman Co. covers hydraulic presses, pumps, and accumulators, as well as forged steel fittings and valves. Section on hydraulic pumps describes vertical, single, two plunger and triplex types; two, four and multi-plunger horizontal pumps.

INSTRUMENTS AND CONTROLS

17 Steam Pump Control Valve—New bulletin tells about the Coffin steam pump control valve and constant pressure regulator. Control valve limits starting power so that pump cannot rise to excessive speed in dry conditions. J. S. Coffin, Jr., Co.

18 Vibration Measuring Equipment—Bulletin GEA-4140 tells about three types of G-E vibration measuring instruments useful for: betterment of product, reduction of damage to machinery and buildings, reduction of noise. Contains useful data on features, selection and operation. General Electric Co.

19 Automatic Controls—Catalog 600 describes the Mercoid line of automatic controls for regulating electrically operated equipment in accordance with changes in temperature, pressure, vacuum, fluid level or mechanical movement. Mercoid Corp.

20 Electric Level Float Control—Described in new folder are ten features of Hancock electric level control. Only one part, no stuffing box, compact, widely used in chemical plants, breweries, pulp and paper mills, heating and refrigerating units. Hancock Valve Div., Manning, Maxwell & Moore.

MECHANICAL TRANSMISSION

21 V-Belt Drive Handbook—A booklet "19 Reasons Why It Is the Dominant Drive of the Industry" tersely pictures the positive grip, evenly balanced load, adaptability and other benefits of multiple V-belt drives. Multiple V-Belt Drive Assn.

22 Variable Speed Transmission—New 4-pg Bulletin No. SJ-44 points out features of Speed-Jack drives and provides helpful specifications and installation data. American Pulley Co.

23 V-Belt Drive Manual—Complete V-belt drive catalog—with all of the required information to make correct drive selections reduced to handy charts, tables and drawings—has just been released by the Allis-Chalmers Mfg. Co. Covered in this Texrope drive engineering summary is the new "Magic-Grip" sheave, designed for fast, easy mounting and dismounting. Also covers "Econograph" method of drive selections.

PIPING, VALVES AND FITTINGS

24 Return Traps—New bulletin tells about operating features and capacities of Templeton return traps for pumping and boiler feeding, draining heaters and vacuum lines, etc. Shows hookup for trap on boiler feed system. Templeton Bros., Inc.

25 Condenser Tube Handbook—Among the subjects covered in Scovill's 56-pg Condenser Tube Booklet are Tube corrosion; Selection of tube material; Composition of tube alloys; Installation methods; Specifications. Also includes useful data tables on gage sizes, conversion factors, formulas, etc. Scovill Manufacturing Co.

(Continued on Page 172)

Coupon must be filled in completely to secure literature you request. Pasting coupon on penny postcard saves time and money.

FEBRUARY, 1945

POWER PLANT ENGINEERING

53 W. Jackson Blvd.
Chicago 4, Illinois

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MORE POWER

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OAKITE CLEANING

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When you clean your Diesel fuel oil filters the more effective Oakite way, you will find that you can simplify this oft recurring job . . . do it quicker and at surprisingly low cost.

Widely-used Oakite cleaning materials and easily installed Oakite techniques are today's most practical answer to efficient maintenance of ALL types of filtering units. Newly-prepared Service Report, FREE on request, gives you complete details!

When writing, ask us also about time-saving Oakite materials and methods for stripping transformers; descaling condensers; cleaning feedwater heaters. There is no obligation.

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Technical Service Representatives Located in All Principal Cities of the United States and Canada

OAKITE *Specialized cleaning*

Buy Bonds for Victory

MATERIALS & METHODS FOR EVERY CLEANING REQUIREMENT

26 Fluid Handling Products—A new, informative catalog, No. 45, on Fluid Handling Equipment for industrial installations features a complete line of Zurn suction and pressure line strainers, such as duplex vertical chamber type strainers, "Y" strainers, and angle type strainers and remote valve control assemblies. Other products described are interceptors for grease, wax, fats, oils and solids. J. A. Zurn Mfg. Co.

27 Prefabricated Piping Data — New 16-pg Bulletin 1034 gives construction details, application pictures, selection data and other useful information on Alco prefabricated piping, pressure vessels and heat exchange equipment. American Locomotive Co.

28 Long-Life Diaphragm Valves — Catalog V-44 pictures the application and performance of Hills-McCanna diaphragm valves on corrosive and non-corrosive liquids, slurries and gases. Contains helpful operating data and service recommendations. Hills-McCanna Co.

29 Hose Coupling Handbook — Described in 48-pg Catalog No. 644 is the complete line of Le-Hi high and low pressure hose couplings. Hints on the selection and care of couplings make this a useful reference book for engineers and maintenance men. Hose Accessories Co.

PRIME MOVERS

30 Diesel Engines — Worthington Pump & Machinery Corp. 8-pg Bulletin No. S-500-B35A gives features, specifications and dimensions of Worthington BB vertical 4-cycle direct-injection Diesel engines.

31 Mechanical Drive Turbines—A series of bulletins describe the complete Terry line of mechanical drive turbines. Bulletin SR-114 covers the Multistage turbine; Bulletin S-107 describes the Axial Flow Impulse turbine; Bulletins S-116 and S-99 describe the Solid Wheel turbine. The Terry Steam Turbine Co.

32 Home Front Jobs for Diesels—Pictured in a new 32-pg booklet just issued by Caterpillar Tractor Co. are tasks its Diesel engines are doing on the home front. Applications include taking over an airport load; lighting municipalities; providing lights and power for service stations, repair shops, roadside stands, auto courts, hotels, hospitals, sawmills, oil fields, cotton gins, flour and feed mills, mines, and radio stations.

33 Steam Engine Data—Bulletin No. 306 gives sectional drawings, construction details and operating information on Troy-Engberg steam engines; discusses savings possible with by-product power. Troy Engine & Machine Co.

MISCELLANEOUS

34 Oil Purification — Attractive 10-pg publication "Clean Oil" reports on outstanding engineering developments in oil purification, discusses problems, describes several types of Honan-Crane clarifiers. Contains many useful filtering system diagrams and installation photos. Honan-Crane Corp.

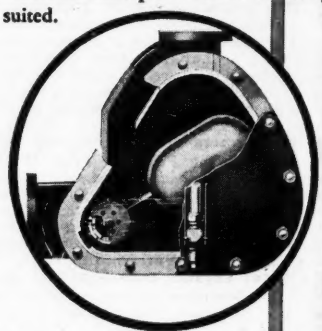
35 High Temperature Insulating Cement—New booklet on Zonolite high temperature insulating cement gives composition, characteristics, uses, specific applications, procedure for applying, coverage, technical data on thermal conductivity, and test results on various mixes. Universal Zonolite Insulation Co.

36 Waterproofing Material—4-pg folder tells how to stop leaks with Flextite without removing water pressure. Flexrock Co.

37 Mobile Swing Boom Crane — New 24-pg catalog gives concise specifications; shows practical application of the Krane Kar swing boom crane in loading, unloading, transporting materials—from one to ten tons. 74 photographs and diagrams. Silent Hoist & Crane Co.

Separators should be drained with COCHRANE *Multiport* DRAINERS

For handling the drainage of low-pressure separators of any make, the Cochrane Multiport Drainer is ideally suited.



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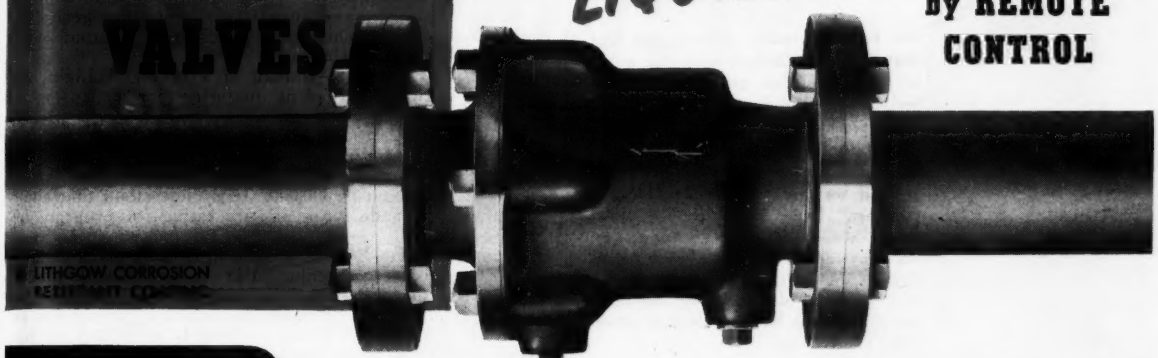

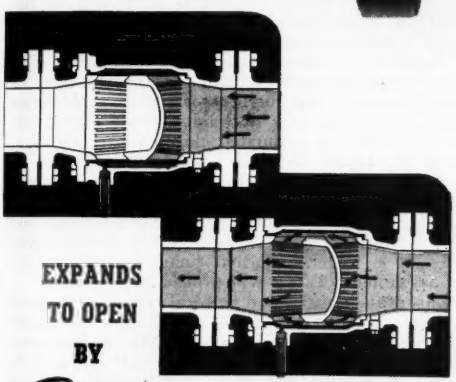

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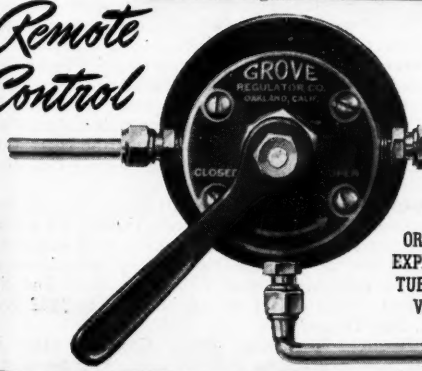

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Grove FlexFlo Valves employ just one (non-metallic) moving part —a flexible synthetic rubber tube which expands to open and contracts to close. Therefore, there are no rubbing surfaces—no seats, discs, stuffing boxes, etc., to wear, stick or leak. All inner surfaces of the valve are completely protected with resilient Lithgow synthetic coating which impregnably resists highly corrosive fluids and gases, and eliminates any possibility of electrolytic action. Line fluid is hermetically sealed off from the external operating medium by the flanged lips of the cylindrical expansible tube which is securely anchored within the valve body. External remote control operation of the FlexFlo Valve may be affected manually, automatically or in combination with automatic control instruments.

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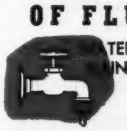

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As government priority construction slackens, however, we will be in a position to offer old and new customers specific help on their problems of power plant construction.

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POWER PLANT *Construction News*

Calif., Burbank—Public Service Department, 174 West Magnolia Blvd., has plans under way for expansion in municipal steam-electric generating station, to be carried out as a postwar project. Program will include addition to present building and installation of turbine-generator, boiler and auxiliary equipment for increased output. Cost estimated about $1,500,000.

Calif., Los Angeles—Bureau of Power and Light, 207 South Broadway, has plans maturing for expansion in Harbor steam-electric generating station, with installation of new turbine-generators, high-pressure boilers and auxiliary equipment for large increased output. Work will be carried out over a 36 months' period, beginning in 1945, and is estimated to cost about $6,300,000. It is understood that application will be made for a priority rating for program for current year.

Conn., Groton—Electric Boat Co., Groton, plans installation of electric power equipment in connection with conversion of one of local submarine shipyards for manufacture of steel shells for Government, for which company has secured large contract. Entire project is estimated to cost about $3,000,000, with machinery. It is understood that financing will be provided by Government.

Idaho, Anderson Dam—Bureau of Reclamation, Custom House, Denver, Colo., is said to be planning early rebuilding of boiler house and compressor station at Anderson Dam, as well as machine and mechanical shop, recently destroyed by fire with loss estimated close to $200,000.

Ill., East St. Louis—General Chemical Co., East St. Louis, plans installation of electric power equipment in connection with expansion in plant for production of sulfuric acid for Government, including additional buildings and machinery for large increased capacity. Cost reported close to $500,000. It is understood that financing will be provided by Government. Work will proceed at once.

Ill., Monsanto—Monsanto Chemical Co., 1700 South Second St., St. Louis, Mo., plans installation of electric power equipment in new additions to plant at Monsanto, near East St. Louis, for manufacture of sulfuric acid for Government. Expansion will comprise several one and multi-story units and is reported to cost approximately $700,000. Project has a priority rating.

Iowa, Forest City—City Light Department, Forest City, has authorized surveys and estimates of cost for extensions and improvements in municipal power plant, including installation of new Diesel engine-generating unit and auxiliary equipment. It is understood that project will be carried out as a postwar development. Stanley Engineering Co., Muscatine, Iowa, is consulting engineer.

Iowa, Des Moines—Solar Aircraft Co., Des Moines, plans expansion in local plant for production of jet propulsion airplane engine parts for Government, and will install machinery and electric power equipment for large increased capacity. Cost estimated about $2,000,000, with financing by Government. Main offices of company are at 1212 West Juniper St., San Diego, Cal.

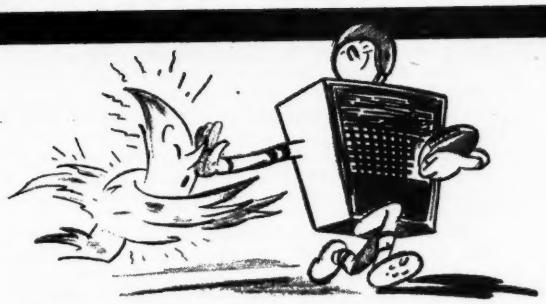
Minn., Cloquet—Northwest Paper Co., has plans for expansion in power plant at mill for increased capacity in steam division. Work will include installation of new boiler unit and auxiliary equipment, and is reported to cost approximately $85,000. It is understood that program has a priority rating.

Minn., Minneapolis—Twin City Rapid Transit Co., 1 South 11th St., operating local traction system, has tentative plans for expansion in steam-electric power plant at 10th Ave. S.E., and Mississippi River, with installation of new turbine-generator unit and auxiliary equipment. Cost reported over $650,000. It is understood that application will be made for a priority rating, providing for work in present year.

N. J., Newark—Anheuser-Busch, Inc., 721 Pestlozzi St., St. Louis, Mo., brewer, has purchased tract of about 18 acres of land on Frelinghuysen Ave. between Evergreen Pl. and McClelland St., Newark, as site for a new brewery, to be carried out as a postwar project. It will comprise

HERE'S ALLIS-CHALMERS' GREAT NEW V-Belt Team!

ALLIS-CHALMERS recommendations for belt selections are unbiased . . . because Texrope's V-belt lineup is *complete.* And as inventor of the multiple V-belt drive, A-C offers sound engineering help . . . backed by the world's longest experience in giving industry money-saving drives.



1 **HEAT-RESISTING SUPER-7** has ability to withstand high ambient built right into it. Standard belt, it can operate in temperatures to 180° F.

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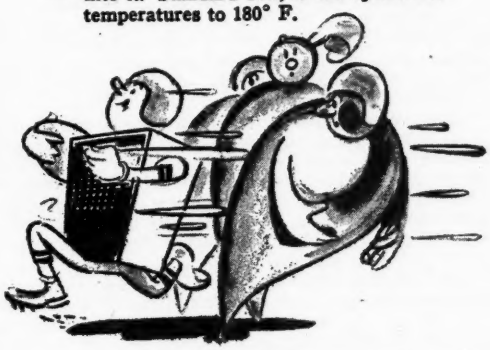

3 **OIL-PROOF SUPER-7,** is solid Neoprene—a synthetic unaffected by most rubber attacking liquids. Recommended for *extreme* oil conditions.

4 **STATIC-RESISTING SUPER-7** *conducts* static charge to machine for grounding charge. This safety belt is applied where explosion danger exists.

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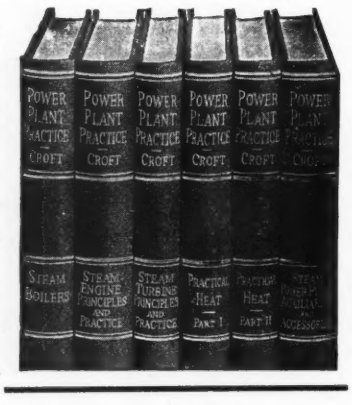

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several one and multi-story buildings, with facilities for large output. Electric power equipment will be installed. A boiler house is planned. No official estimate of cost announced, but reported in excess of $1,000,000.

N. M., Gallup—Electric Power Department, 104 West 66th Ave., has completed plans for new municipal steam-electric power plant, to be carried out as a postwar project. Cost estimated about $750,000, with equipment. Heretofore municipality has purchased its power supply.

N. C., Ocracoke—Ocracoke Power & Light Co., Ocracoke, has plans under way for addition to oil engine-operated generating station, including installation of additional equipment for increased capacity. No estimate of cost announced. Financing will be provided by Federal aid.

N. C., Plymouth—North Carolina Pulp Co., manufacturer of bleached and unbleached paper board and paper specialties, plans installation of electric power equipment in new addition to mill for increased capacity. Cost reported over $200,000. Work will begin at early date. Project has a priority rating. Carson & Carson, Commercial Trust Bldg., Philadelphia, Pa., are consulting engineers.

Ohio, Arcanum—Water and Electric Light Department, South St., has authorized surveys and estimates of cost for extensions and improvements in oil engine-operated municipal power station, including installation of equipment for increased capacity. It is understood that work will be carried out as a postwar development. C. J. Simon & Associates, 238 North Harrison Ave., Van Wert, Ohio, are consulting engineers.

Ohio, Groveport—Columbus & Southern Ohio Electric Co., Columbus, Ohio, has plans maturing for expansion in steam department at generating station at Groveport, including installation of new high-pressure boiler unit, coal pulverizing equipment, coal and ash-handling machinery and auxiliary equipment. Cost reported over $1,200,000. Project is said to have a priority rating.

Ore., Lakeview—Navy Department, Washington, D. C., plans boiler house for heating service at Naval Auxiliary Air Station, Lakeview. Work will be carried out in connection with other extensions at station, entire program to cost about $165,000. Bureau of Yards and Docks, Navy Department, Washington, D. C., is in charge.

Ore., West Salem—Blue Lake Producers Cooperative, West Salem, plans early rebuilding of food processing and canning plant, recently destroyed by fire, consisting of a one-story structure, 260 x 300 ft, with loss reported over $200,000. Electric power equipment will be installed. A boiler house is planned. Application has been made for a priority rating. Lyle P. Bartholomew, Salem, is architect. O. E. Snider is manager.

Pa., Warren—Pennsylvania Electric Co., Johnstown, Pa., has selected tract of close to 100 acres of land at Warren, and will use as site for new steam-electric generating station, to be carried out as a postwar project. Initial installation will include a 30,000-kw turbine-generator unit, high-pressure boiler and auxiliary equipment. Cost reported in excess of $2,000,000, including new transmission line for connection with present high-tension system.

Texas, Houston—Kelly-Springfield Tire Co., Cumberland, Md., has plans for new plant for manufacture of truck tires on site near Pasadena, Houston, consisting of several large processing and manufacturing units. Electric power equipment will be installed, including power substation unit and transformer stations. New mill will use synthetic rubber produced at plant of Goodyear Tire & Rubber Co., Akron, Ohio, in immediate vicinity. Cost estimated over $5,000,000, with machinery. Project has a priority rating. Company is a subsidiary of Goodyear company noted.

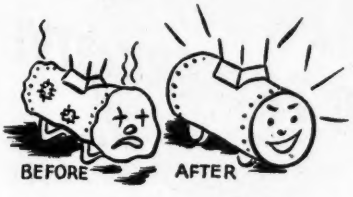
Va., Orange—Snead & Co., 96 Pine St., Jersey City, N. J., manufacturer of metal shelving, partitions, etc., plans installation of electric power equipment in connection with expansion in plant at Orange for production of munitions for Government. Project will include additional buildings with machinery for large output. Cost estimated about $500,000, with financing provided by Defense Plant Corp., Washington, D. C., Federal agency. Work is scheduled to begin at once.

Wash., Wenatchee—Washington Water Power Co., 825 Trent Ave., Spokane, Wash., will make extensions in transmission lines around Wapato Lake and thence to Manson Reclamation District, where power will be furnished. Program will include a power substation and other operating facilities. No estimate of cost announced. Priority rating has been secured.

HOW OUR FLYING *Trouble-shooter* *Saved* $30,000.00 For a Southwest Utility Plant

Another illustration of how Conseco Engineers give better, faster service on condenser repairs

This happened a few months ago, when a 35,000 sq ft condenser shell, a cast iron turbine casing and an exhaust trunk blew out in one of the largest utility plants in the southwest. After learning that the best delivery they could get on a new shell was 12 weeks, and that a new trunk and casing would take 16 weeks to build by the original manufacturer, they phoned Condenser Service.



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Here's how we did it. We built a new shell 2 in. shorter than the old one, so we could use the old tubes and other serviceable parts of the old condenser, built a new exhaust trunk, and patched the old turbine casing in over 400 places.

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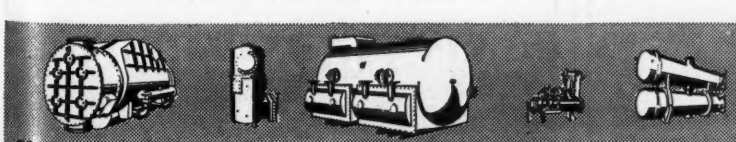

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Floors are made impervious to oils and grease with

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"Dusting" is prevented by using

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Prevent accumulation of foreign matter by sealing the pores in concrete surfaces with

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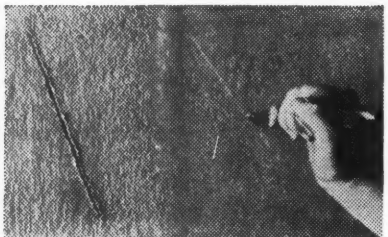

Unretouched photograph of concrete surface partly treated with

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Note how the dense hardness of treated section prevents sharp edge of tool from gouging surface.

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MAGIC BOILER PRESERVATIVE

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"MAGIC" Boiler Preservative has the big advantage of being non-volatile. It will not evaporate or distill over with the steam.

The steam from boilers using "MAGIC" is pure and free from any chemicals or injurious gases. It can be used directly in processing industries without injury to products.

Remember, too, that "MAGIC" puts a protective film on the iron which not only prevents scale from adhering, but also helps to prevent pitting, corrosion and leaks.

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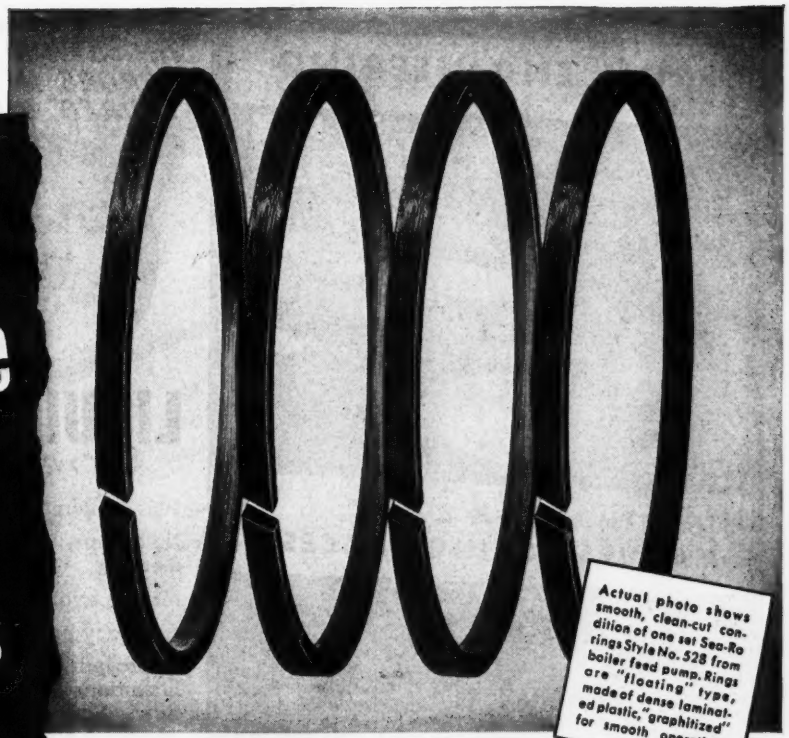

Actual photo shows smooth, clean-cut condition of one set Sea-Ro rings Style No. 528 from boiler feed pump. Rings are "floating" type, made of dense laminated plastic, "graphitized" for smooth operation.

Thanks to Sea-Ro Pump Plunger Rings

HUDSON RIVER DAY LINE, in March 1939, ordered two sets Style No. 528 rings for the Peter Stuyvesant's boiler feed pump. November 1944, 5 years later, after rings had been used 6 full seasons of 4 months each, new rings were installed. Operating conditions:

- **Temperature 220° F**
- **Pressure 225-250 lbs per sq inch**
- **Ring wear less than 1/64 inch**

Pack a pump and forget about it. That's what you can do when Sea-Ro rings are installed. No worry about swollen, jammed packing. Sea-Ro rings gave worry-free service for the Hudson River Day Line over a period of 5 years, operating 4 months a year for six seasons. That's the kind of dependable service these tough, long-wearing rings are rendering on merchant and Navy ships, in power and industrial plants.

The Sea-Ro Style No. 528 ring is especially recommended for the "tough jobs" where high temperature and pressure exist. Each set of rings is precision-ground to individual pump specifications. Ask for further details.

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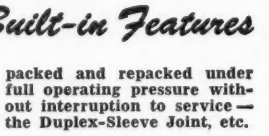
ADSCO EXPANSION JOINTS

Offer Exclusive Built-in Features

In ADSCO'S large, modern plant with foundry and expert welding equipment, skilled workmen make a wide range of ADSCO Expansion Joints to meet exact code standards. They build them with bronze, semi-steel or steel bodies — for controlling the expansion of low or high pressure steam, hot water, gasoline, oil, air or other pipe lines.

Exclusive features of ADSCO Joints include the internal guide ring to prevent the slip from pulling out of the body — the external, two-piece removable guide — the Piston-Ring joint which can be unpacked and repacked under full operating pressure without interruption to service — the Duplex-Sleeve Joint, etc.

All joints described in ADSCO Catalog No. 35E.



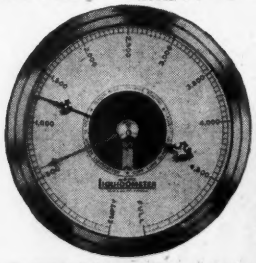
ADSCO Piston-Ring Joint

AMERICAN DISTRICT STEAM COMPANY

NORTH TONAWANDA, NEW YORK

Makers of "UP-TO-DATE" Steam Line Equipment For Over 65 Years

THOSE WHO CAN'T AFFORD TO MAKE ERRORS IN MEASURING VALUABLE STORED LIQUIDS CHOOSE —



LIQUIDOMETER *Tank Gauges*

"THEY'RE ALWAYS DEPENDABLE"

100% automatic.

No pumps, valves, or auxiliary units needed to read them.

Models available for either remote or direct readings.

Accuracy unaffected by specific gravity of tank liquid.

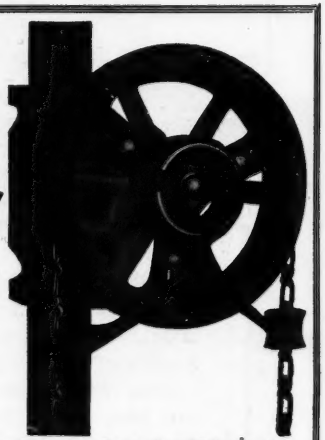
Approved by Underwriters' Laboratories for gauging hazardous liquids.

Write for complete details.

THE LIQUIDOMETER CORP.

36-31 SKILLMAN AVE., LONG ISLAND CITY, N.Y.

For All "HIGH-UP" VALVES



Every overhead valve in your plant should have the easy, safe, instant control from the floor which Babbitt Sprocket Rims provide. . . . Babbitt Rims are low in cost; quickly attached; they save time, steam and accidents. Install them now. Write for descriptive folder.

BABBITT STEAM SPECIALTY CO.

South Water, Spring and First Sts.

New Bedford, Mass., U. S. A.

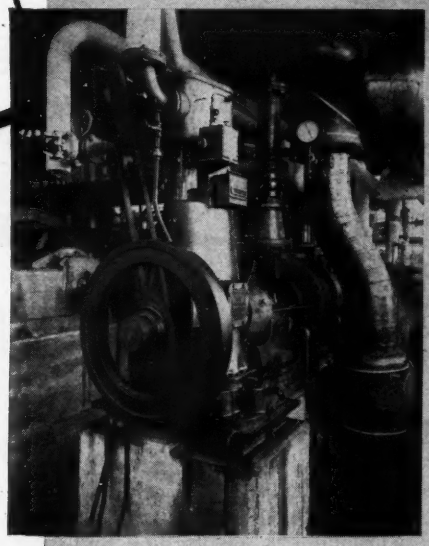
Babbitt

—Adjustable—

SPROCKET RIM

with Chain Guide

TROY-ENGBERG POWER

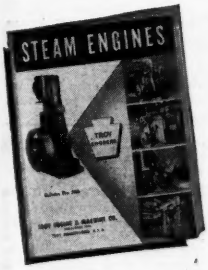


Low Cost because It's
BY-PRODUCT POWER

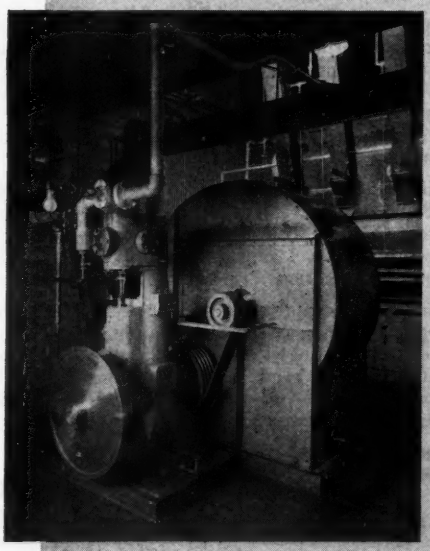
SOME look for certain characteristics in a drive, such as flexibility, or wide speed range, or high starting torque, or sustained overload capacity. But *all* look for the lowest cost consistent with other requirements.

In the Troy-Engberg Steam Engine, you can find all. With the proper heat balance, it will produce power at a lower cost than any other drive.

How about a Troy-Engberg Steam Engine for your plant—to drive that stoker, or compressor, or pump, or fan?



Tell us about the equipment for which you need a drive, the available steam and where you can use the exhaust steam for processing or heating.

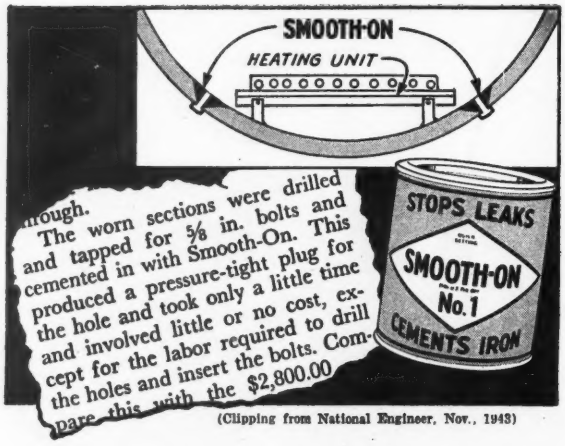


TROY ENGINE & MACHINE CO.

Established 1870

872 Railroad Avenue **Troy, Pennsylvania**

2-TEM-4



...rough.
The worn sections were drilled and tapped for 5/8 in. bolts and cemented in with Smooth-On. This produced a pressure-tight plug for the hole and took only a little time and involved little or no cost, except for the labor required to drill the holes and insert the bolts. Compare this with the $2,800.00

(Clipping from National Engineer, Nov., 1943)

$2800 SAVED

by using a little

SMOOTH-ON No. 1

After many years of service a 20,000-gallon steel storage tank for fuel oil developed a leak. Inspection disclosed that the leak was due to a small hole caused by friction. An improperly installed heating unit had developed movement, bringing a sharp edge into contact with the tank wall.

Remedy was simple. The hole—and another incipient one—were drilled and plugged with 5/8" bolts cemented in with Smooth-On No. 1, and worn spots also filled in with additional Smooth-On; and the tank was ready for many more years of service, as reported in a recent issue of National Engineer (see reproduction above).

This Smooth-On repair saved a heavy expenditure of $2800 for a new tank, and probably much inconvenience. Yet its cost was infinitesimal—just a little Smooth-On No. 1 and a small labor charge. No heat required, no serious dismantling.

For half a century, Smooth-On has been used for stopping leaks, sealing cracks, tightening loose parts effectively, lastingly. Most engineers and maintenance men keep a can handy for both emergency and routine repairs. In 1-, 5-, 25-, and 100-lb. sizes at your supply house, or, if necessary, direct from us.

FREE VALUABLE REPAIR HANDBOOK

40 pages. 170 diagrams. Clear, concise, tested directions for ingenious repairs to plant equipment, structures, pipe lines, etc. Pocket size. Handy index.

SMOOTH-ON CEMENTS

Motor Car and Boat Home, Factory and Power Plant

Mail this today

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570 Communipaw Avenue
Jersey City 4, N. J.

Please send the Repair Handbook.

Name .....

Address .....

2-45 .....

Do it with **SMOOTH-ON**
The Iron Repair Cement of 1000 Uses

WANTED:

NEW POWER PLANT SPECIALTIES

To Manufacture and Market

A manufacturer of steam power plant equipment with 40 years' experience in this field and a nationwide sales organization is interested in adding several new products to his line. This company has a strong financial position and has adequate research facilities for testing new products and doing any further development that may be needed. Address all information to

WITTE & BURDEN • ADVERTISING
5757 Cass Ave., Detroit 2, Mich.

Spare the Chisel - Save the Parts USE KROIL

The oil that creeps and loosens frozen parts . . . The new chemical that will pass through openings as small as a millionth inch . . . proved by laboratory tests.

Thousands of industrial concerns are using Kroil regularly to keep production going. Read these case histories:

Frozen Pulley Shaft
Because of a frozen pulley shaft plant officials were resigned to a half-day's tieup in production. Kroil was rushed to the rescue. Result: Production resumed in fifteen minutes.

Worn, Rusted Bolts
"The bolts were badly worn and rusted . . . he had pounded on them with a heavy sledge and had been unable to get them out . . . He put some Kroil on these bolts and went out to lunch and when he came back he was able to turn them out with his bare hands."

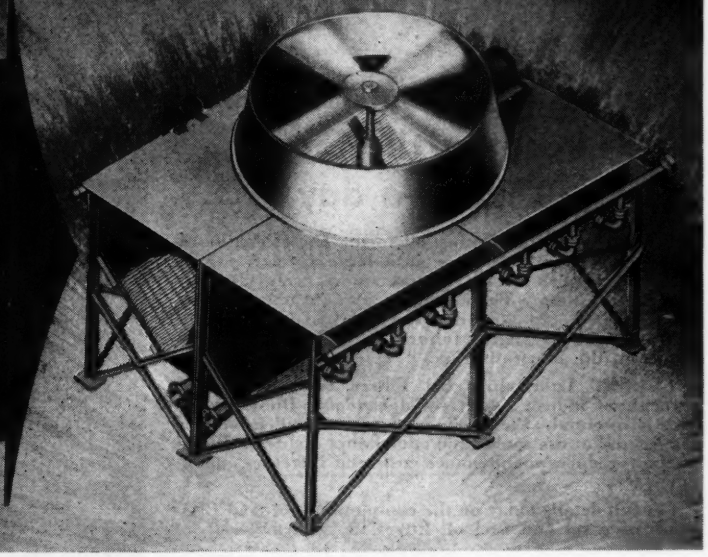
Repair Plugged Valves
. . . A sulphur mine . . . "This equipment is very mean to work on due to the highly corrosive conditions. The foremen tell me that they find Kano Kroil a big improvement over other oils used in the past. We also used it in breaking down for repair, steam-jacketed plug valves which have been in the sulphur."

Wherever there is corrosion Kroil will loosen metal joints in a few minutes' time, saving labor, equipment and temper. Try it on a money-back guarantee. Gallon, $3.00, f.o.b. Chicago.
KANO LABORATORIES 67 East Wacker Drive, Chicago 1, Ill.

KANO LABORATORIES

Efficient Cooling Without Water—

THE NEW ALCO AIR-COOLED HEAT EXCHANGER WILL DO THE JOB BETTER



Here's why:

1. Works at high air temperatures—reliable at all seasons of the year.
2. Extended-finned heat-transfer surfaces.
3. Uniform air distribution by induced draft—high-velocity, vertical discharge prevents recycling of hot air.
4. Because of design, efficiency is not affected by change of wind direction.
5. Not affected by high humidity.
6. Design and construction make field assembly and erection easy and quick.
7. Sturdy steel construction—ample safety factor against high winds.
8. Minimum operating and maintenance expense.
9. Engineered for your specific application from a selection and combination of four standard sizes and five standard coil or core designs for each frame size.
10. In restricted areas the equipment can be mounted on top of existing structures.
11. Recommendations for equipment supplied may be based on a special survey of conditions peculiar to your application by experienced ALCO thermal engineers.
12. Designed, built, sold, guaranteed and serviced by ALCO—with more than 20 years of experience in thermal engineering.

Typical Applications:

1. Jacket water for Diesel and gas engines.
2. Lubricating oil cooling—cools crank case oil in Diesel and gas engines.
3. Cooling gears in large gear boxes, speed reducers, etc.
4. Steam condensing—steam engine, process steam.
5. Gas cooling and vapor condensing—chemical plants, petroleum refineries, etc.
6. Heat-treating metals—cooling bath.
7. The standard air cooled exchanger can be arranged to perform several services simultaneously—such as cooling lube oil, jacket water and gas.

Practical Problems this ALCO Equipment overcomes include:

1. Insufficient water supply.
2. Scale from bad or brackish water.
3. Elimination of expensive water treatment.
4. Waste water disposal difficulty.
5. High-cost water and pumping.
6. High relative humidity.
7. Limited installation space.

Write for new ALCO bulletin No. 1035

This equipment is fully described and illustrated in a new ALCO Bulletin, now ready. Contains standard specifications. Copy sent promptly on request. Write for your copy now.

American Locomotive

ALCO PRODUCTS DIVISION

30 Church Street, New York 8, N. Y.
Dunkirk, N. Y.

NUGENT TRADE MARK

Nugent Filter

helps supply-port crane keep on the job 24-hours a day

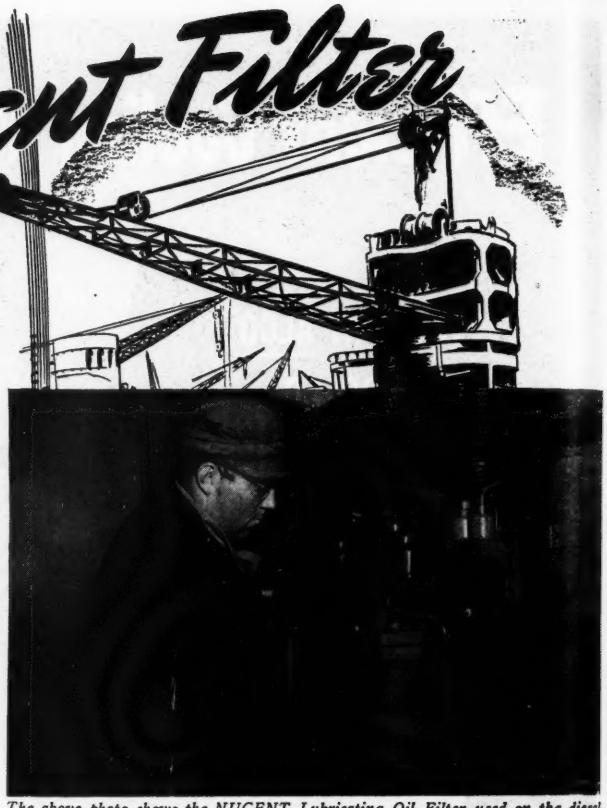
Protecting the lubricating oil in the Diesel engine of an electric crane operating at a large foreign supply port is another vital wartime task performed by NUGENT Filters. These cranes operate many times throughout the 24 hour day and it is essential to minimize the risk of engine failure due to dirt or foreign matter in the lubricating oil.

NUGENT Lubricating Oil Filters are widely used throughout industry wherever *dependable* Diesel operation is essential. Clean oil helps to keep oil in service longer and at the same time adds hours of life to Diesel engines, reduces maintenance costs and increases engine efficiency.

Get full details today on the complete line of NUGENT lubricating oil and fuel oil filters for your Diesels.

WM. W. NUGENT & CO., Inc.
Est. 1897

423 N. Hermitage Avenue, Chicago 22, Ill.



The above photo shows the NUGENT Lubricating Oil Filter used on the diesel engine of the huge electric crane operating at a busy supply port. Patented construction gives this unit 468 sq. in. of filtering area.

Specify:

ERNST

HIGH and LOW Alarm
INCLINED
Water Columns
PRISMATIC REFLEX TYPE

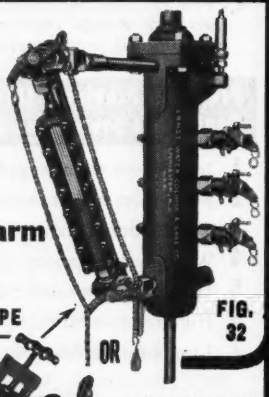


FIG. 32

OR

SPLIT GLAND TYPE

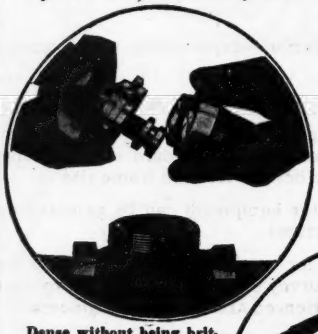
FIG. 1

Send for Catalog 45
TEL.: LIVINGSTON 6-2356

ERNST WATER COLUMN & GAGE CO.
LIVINGSTON, NEW JERSEY

Use VULCODISC

for trouble-free valve jobs



In renewing the disc, note how easily and quickly the Vulcodisc Jiffy Disc Holder slips off the stem head. Only the disc lock nut to remove and the old disc is off and replaced in a jiffy.

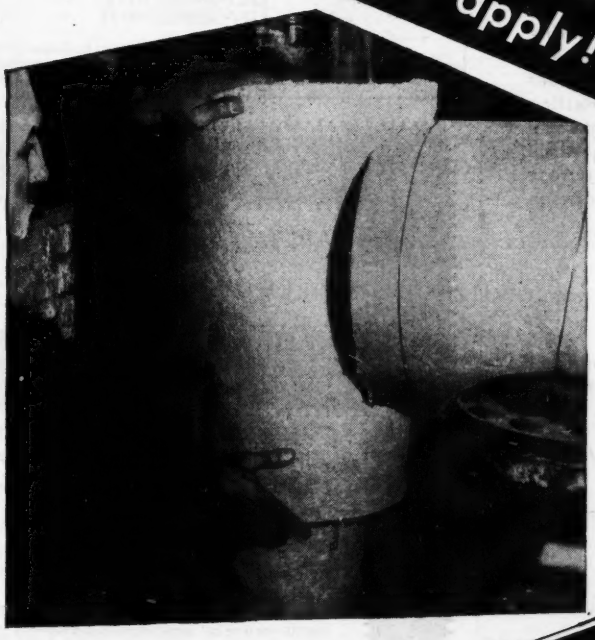
Dense without being brittle—tough, yet resilient, Vulcodisc will not swell, warp or soften—in fact its absorption is less than 1 per cent . . . That is why an old Vulcodisc comes out of the disc holder as easily as a new one goes in. No need for hammer and chisel to cut the disc out in pieces—distorting and disfiguring the holder.
Write for descriptive bulletin.

THE D. T. WILLIAMS VALVE CO.
Cincinnati, Ohio

GETTING "HOT UNDER THE COLLAR"?

SIMPLY APPLY UNIBESTOS

it's simple to apply!



It's easy to cover flanges and fittings with Unibestos, the sectional insulation. Unibestos saws or cuts clean and sharp with ordinary tools—no mess. Here's how it's done: bring adjacent pipe covering up to proper level by use of a collar of a standard section of Unibestos and then simply span both flanges with a single piece of sectional Unibestos properly cut to fit. That's all there is to it!... and you have a smooth, neat, efficient and readily-removable installation.

UNION ASBESTOS
MEANS PROGRESS IN INSULATION
AND RUBBER CO.

ARMY ARMY E NAVY

PLANTS: 1821 S. 54th Ave., CICERO, ILL. • PATERSON, N. J. • BLUE ISLAND, ILL.
OFFICES: CHICAGO • CICERO, ILL. • NEW YORK • SAN FRANCISCO • PATERSON, N. J.

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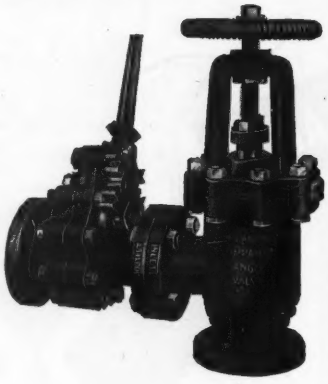
UNION ASBESTOS AND RUBBER CO.

2 IMPORTANT ADVANTAGES

. . . in this DUPLEX BOILER BLOW-OFF UNIT



1. Tightness

. . . is assured and maintained by the self-grinding seal of the Everlasting Blow-off Valve and the narrow, flexible sealing ring of the Everlasting Companion Angle Valve. In the Everlasting Blow-off Valve, the disc moves across the seat in *rotating motion* and is in *constant contact* with the seat, thus regrinding the disc against the seat whenever the valve is opened or closed. In the Everlasting Companion Angle Valve, a perfectly fluid-tight seal is provided by the flexible narrow-face ring which yields to slight irregularities of the sealing surface and the sealing edge as it is compressed between them.

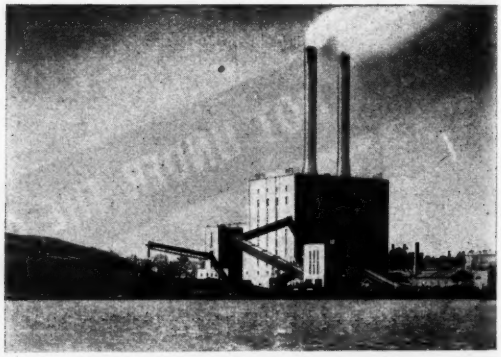
2. Resistance to wear

. . . is provided by the constant spring-maintained contact of disc and sealing surface which prevents grit from getting between the sealing faces of the Everlasting Blow-off Valve disc and seat; and by the design of the Everlasting Companion Angle Valve in which the sealing elements are not subject to destructive erosion from the flow of fluids.

Made in sizes 1½-in., 2-in., and 2½-in. for 250-lb., 300-lb. and 600-lb. Comply with all code requirements.

EVERLASTING VALVE COMPANY
49 Fisk Street, Jersey City 5, N. J.

Everlasting Valves
for everlasting protection



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Coal Preparation by "Pennsylvania" Bradford-Hammermill

"Pennsylvania" STEELBUILT Coal Preparation Machinery, developed during the past 40 years, in six types and over 150 sizes, has been specialized for the requirements of Central Stations, Industrial Power Plants, By-Product Coke Plants, Mines and Coal Cleaning Plants.

Experience with a steadily increasing number of installations, with capacities now totaling well over 200,000,000 tons per annum, is the basis for our recommendations of efficient Coal Preparation Equipment, specialized for your requirements.

Our Engineers are at your service

PENNSYLVANIA CRUSHER COMPANY

1706 Liberty Trust Bldg., Philadelphia 7, Pennsylvania
New York, Pittsburgh, Chicago, Los Angeles, Birmingham
Associated with Fraser & Chalmers Engineering Works, London

LAN NOW FOR 1945 WITH MERCOID CONTROLS

MERCOID HAS WHAT EXPERIENCED ENGINEERS WANT IN AN AUTOMATIC CONTROL

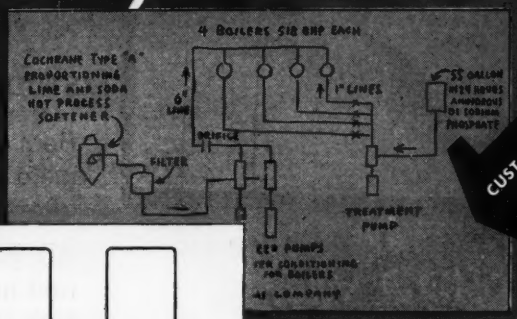
1. Designed for positive safety—*the prime purpose of a control.*
2. Built for years of dependable performance—*a very desirable feature.*
3. Simplified for ease of installation—*appreciated by the trade.*
4. Convenient facilities for making understandable adjustments—*no time lost in calculating or guesswork.*
5. The only 100% Mercury Switch Equipped Control Line—*which means that all "makes" "and breaks" in the electrical circuit are hermetically sealed, therefore immune to dust, dirt, corrosion, open arcing, pitting, or sticking of contacts—all common causes of contact trouble. Mercoid Switches provide an electrical contact that will give millions of perfect operations.*

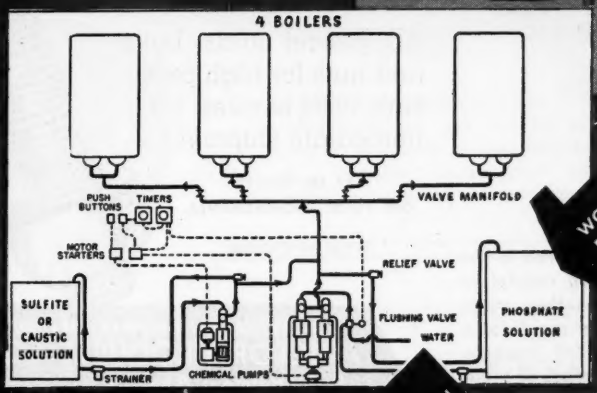
The above facts merit your consideration. For detailed information see Mercoid catalog No. 600.

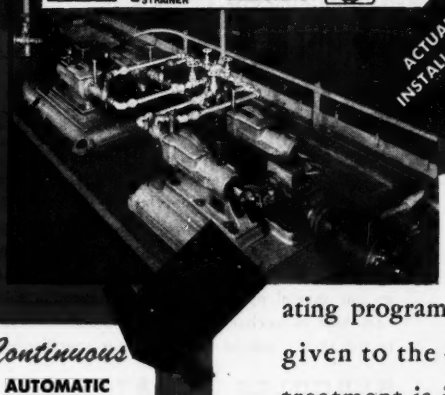
THE MERCOID CORPORATION
4203 BELMONT AVE. CHICAGO 41, ILL.

Working PRINCIPLE

Adding the *proper* treating chemical, in the *correct* proportion, in the *right* location, at the *right* time.







TO *Mechanize* YOUR BOILER WATER CONDITIONING

The success of your chemical treatment depends on strict adherence to an operating program. In many cases insufficient importance is given to the *method* and *regularity* with which the treatment is injected. By using the tried and proven %Proportioneers% system, you eliminate guesswork, assure accurate treatment, safeguard your boiler investment, improve heat transmission, save fuel and reduce costly shutdowns for repairs and cleaning.

Ask for Bulletin 1713

Continuous AUTOMATIC WATER CONDITIONING WILL WORK FOR *You*

% PROPORTIONEERS, INC. %

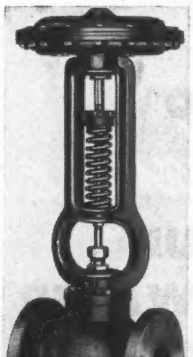
WRITE TO %PROPORTIONEERS, INC.% 46 CODDING ST., PROVIDENCE 1, RHODE ISLAND

to *Simplify* the selection of Pressure Regulators . . .

	FOR STEAM, AIR AND GAS *ALSO RECOMMENDED FOR WATER AND OIL											FOR WATER			FOR GAS	
REGULATOR No.	2"	8	13	14"	15	16"	18"	19"	26"	27"	40	49"	40E"	17	21	46	9	29
MAXIMUM INITIAL PRESSURE	600	1500	400	600	250	400	250	250	125	125	600	1500	1500	250	125	400	250	250
MINIMUM REDUCED PRESSURE	1	0	½	0	0	0	↑	↑	↑	↑	1	0	1	0	½	10	¼	¼
MAXIMUM REDUCED PRESSURE	125	300	100	200	30	125	↓	↓	↓	15	300	100	300	100	80	200	100	100
FOR DEAD END SERVICE			✓				✓	✓	✓		✓	✓		✓	✓	✓		
DIAPHRAGM ACTUATED—Direct Acting			✓	✓	✓	✓	✓	✓	✓	✓					✓		✓	✓
PISTON ACTUATED—Direct Acting	✓										✓	✓	✓	✓		✓		
AUXILIARY PILOT CONTROL		✓						✓	✓	✓	✓	✓			✓	✓		
SPRING LOADED			✓	✓		✓	✓							✓			✓	✓
WEIGHT LOADED	✓	✓			✓	✓					✓		✓	✓	✓	✓	✓	✓
SERVICE: GENERAL SERVICE	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓
SERVICE: LOW PRESSURES—Metering	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓		
SERVICE: HEAVY LOAD DEMANDS		✓				✓	✓						✓	✓				
SERVICE: SPECIAL SERVICE		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓					
RANGE OF SIZES	½ to 16	4 to 24	½ to 2	½ to 16	½ to 16	½ to 16	½ to 16	½ to 16	½ to 8	½ to 8	½ to 16	½ to 16	½ to 16	¾ to 6	¾ to 2	¾ to 16	½ to 16	½ to 16

. . . consult

DAVIS



Above—No. 14 Direct connected spring loaded regulator. For steam, air, gas, water, oil. For pressures to 400 psi. For reduced pressures 0 to 200 lbs.

The variables encountered in the application of pressure regulators are so numerous that they make selection of the proper regulator a tough job at best. Yet, because choice of the proper types of regulator determines to such a very great extent the efficiency of the installation, it is essential that the job of selection is not slighted. To help you choose the proper regulator, Davis offers a number of helps:

1. A truly complete line of regulators to meet nearly every conceivable requirement. 18 different types for steam, air, gas, water, oil. Sizes to 24". For pressures to 1500 lbs.

2. Literature and selection charts that provide complete information in easy-to-use form.

3. Engineering consultation on regulator problems.

4. Ability to design regulators to meet any requirement, no matter how special.

For additional information, write today on your company letterhead and request a copy of Bulletin 100 A.

Above—No. 40 for heavy duty, variable load conditions. Unaffected by high pressure fluctuations. Self-contained. Pilot operated. For pressures to 400 psi.

DAVIS REGULATOR CO.

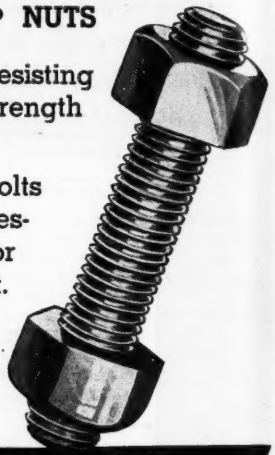
2508 S. Washtenaw Ave., Chicago, Ill.

DAVIS REGULATOR COMPANY

VICTOR *Custom* FASTENINGS

***for* Power Plants and all Heavy Industries**

STUDS • BOLTS • NUTS



Heat and corrosion resisting metals and high strength alloy steels.

Alloy steel studs, bolts and nuts for high pressure uses stocked for immediate shipment.

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2639 Belmont Ave. • Chicago, Ill.

666,000 Is a Lot of Floats,

but that number of Hercules Seamless Floats is now in service. We've been making them since 1894, selling them with a full year's guarantee to stand up under as high as 350 lbs. working pressure and 500 degrees temperature. Made of seamless copper, by our special process they are uniform in thickness, high in mechanical strength. Standard shapes up to 18 in.; special types to your specifications.

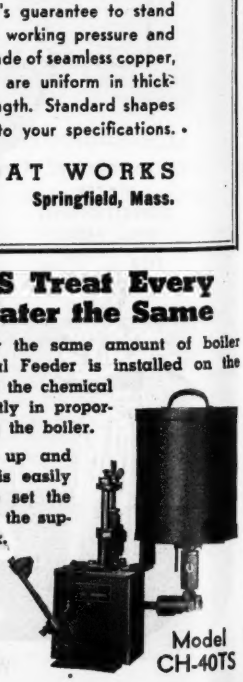
HERCULES FLOAT WORKS

200 Franklin St. Springfield, Mass.

MANZEL FEEDERS Treat Every Gallon of Feed Water the Same

Every gallon of water gets exactly the same amount of boiler compound when a Manzel Chemical Feeder is installed on the boiler feed pump. The Feeder injects the chemical in accurately metered amounts exactly in proportion to the amount of water entering the boiler.

The feeder starts, stops, speeds up and slows down with the pump. Feed is easily regulated and very accurate. Once set the only attention required is to maintain the supply of chemical in the chemical tank.



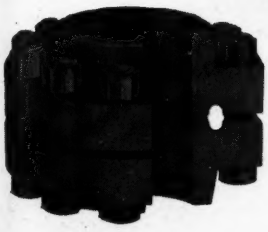
Model CH-40TS

Write for Bulletin

MANZEL BROTHERS COMPANY

327 Babcock St., Buffalo 10, N. Y.

REDUCE POWER LOSSES WITH PRESSURE PROOF JOINTS THAT ARE AS TIGHT AS A WELD



THESE GASKETS used at all flange connections, valve bonnet joints, and at joints where ready disassembly is a necessary requirement, reduce power losses and shut-down time for pressure lines and pressure vessels.

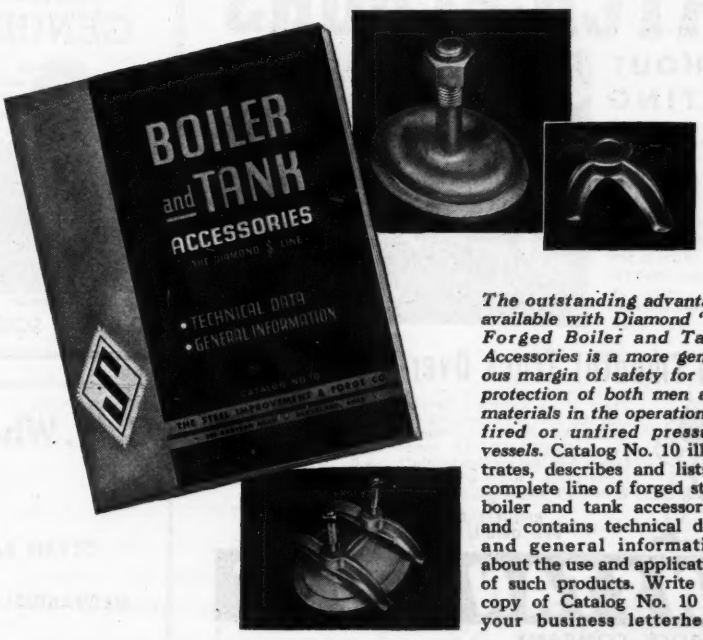
With Gruv-Seal "Forged-Iron" Ring Gaskets, wrench pressure molds a tight seal that stays tight.

These gaskets are manufactured by a special forging method which eliminates metal porosity and interlocks the metal fiber lines into a dense, tough structure such as is obtained by no other fabricating process. Gruv-Seal "Forged-Iron" Ring Gaskets are exact in every detail; true in diameter, circumference, and in thickness; perfectly proportioned and machined to a fine, smooth finish. The metal from which these are forged possesses corrosion-resisting properties beyond those of ordinary steels. Gruv-Seal "Forged-Iron" Ring Gaskets are made in a wide range of sizes, including all standard A.P.I. sizes. New sizes are constantly being worked out as requirements occur. Write for special bulletin on Gruv-Seal "Forged-Iron" Ring Gaskets.

These gaskets are one item of the complete line of Diamond "S" Forged Boiler and Tank Accessories which includes manhole cover assemblies, handhole cover assemblies, welding street ells, welding fittings, special flanges, water column ells, welding necks, all of which are forged to close tolerances from suitable metals, and fully meet and exceed A.S.M.E. requirements for steel use in pressure vessel parts.

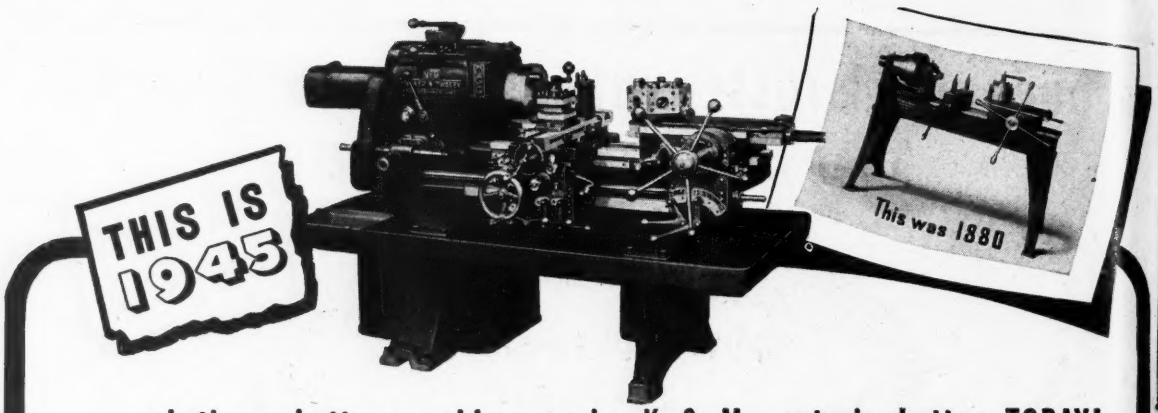
THE STEEL IMPROVEMENT & FORGE CO.
966 E. 64th Street • Cleveland, Ohio

The Improvement of Metals by Forging *is exemplified by* DIAMOND "S" FORGED BOILER & TANK ACCESSORIES



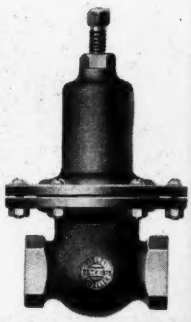
The outstanding advantage available with Diamond "S" Forged Boiler and Tank Accessories is a more generous margin of safety for the protection of both men and materials in the operation of fired or unfired pressure vessels. Catalog No. 10 illustrates, describes and lists a complete line of forged steel boiler and tank accessories, and contains technical data and general information about the use and application of such products. Write for copy of Catalog No. 10 on your business letterhead.

DROP FORGINGS
THE STEEL IMPROVEMENT & FORGE CO.
966 East 64th Street • Cleveland, Ohio



. . . and these better machines make K & M controls better TODAY!

Built into every K & M Control is *experience plus* . . . not merely our own 66 rich years of pioneering and progress . . . but all the benefits of the know-how of other seasoned old-timers. For instance, Warner & Swasey. We've used their turret lathes since 1880, starting with the plain little fellow up above. Our new plant uses big babies that tool to a ten-thousandth. Dependable as they've always been, K & M Controls are better than ever today! Pictured is the compact K & M type 590 Diaphragm Relief Valve for pressures from 5 to 100 lbs., with a wide range of adjustability above or below pressures desired. Sizes ⅜" to 2"—angle or globe—set screw, hand wheel or test lever adjustment—with discs and diaphragms suitable for steam, water, air, oil or gas service.



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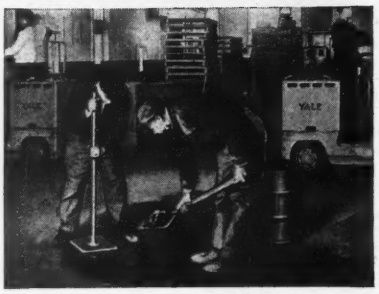
MANUFACTURERS OF PRESSURE AND LEVEL CONTROLS SINCE 1879

2009—43rd St., North Bergen, N. J.

66 YEARS OF CONTROL PROGRESS

PATCH FLOORS

WITHOUT HALTING TRAFFIC



No longer is it necessary to close off an area of concrete floor while waiting for newly installed patches to set. Flexrock offers a new plastic repair material which is ready for traffic almost the moment it's put down.

Tamp Smooth! Truck Over Immediately!

There is no waiting. Simply shovel INSTANT-USE into the hole or rut—tamp—and your floor is restored to solid smoothness . . . back in service without delay. Tough INSTANT-USE bonds tight to old concrete, makes long-lasting heavy duty patch. Withstands extreme loads. Keep a drum on hand for emergencies. Immediate shipment.

REQUEST DESCRIPTIVE FOLDER and Details of FREE TRIAL OFFER

INSTANT-USE

FLEXROCK COMPANY

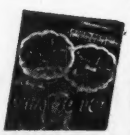
3623 Filbert St., Philadelphia 4, Pa.

Please send me complete INSTANT-USE information and details of FREE TRIAL OFFER—no obligation.

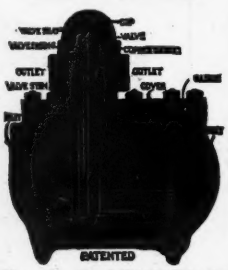
Name .....

Company .....

Address .....



The GENUINE Squires STEAM TRAP



saves your fuel bill as it operates without loss of steam.

May we send Catalog E-9 giving complete information.

The C. E. SQUIRES CO., Cleveland, O.

C. H. Wheeler of Philadelphia

STEAM CONDENSERS

•

STEAM EJECTOR TYPE VACUUM PUMPS

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MECHANICAL DRAFT WATER COOLING TOWERS

•

DECK MACHINERY

C. H. WHEELER MFG. CO.

19th ST. and LEHIGH AVENUE, PHILADELPHIA 32, PA.

WHAT HAS OTIS ELEVATOR COMPANY BEEN DOING?

...and what are they PREPARED to do?

The factories of the Otis Elevator Company have been devoted one hundred per cent to the war effort. That's not unique. That's the pattern of American industry.

however...

In addition to our large scale production of a great variety of highly precise mechanisms of war for the Army, Navy, and the Air Corps, we have continued to produce elevators. We have manufactured freight as well as passenger elevators for hospitals, ordnance depots, naval warehouses, and other priority installations.

this means...

Although our facilities, organization, and resources have enlisted for the duration and have gone all out for war production *as a matter of actual fact we have never been out of the business of manufacturing, installing, and servicing elevators.*

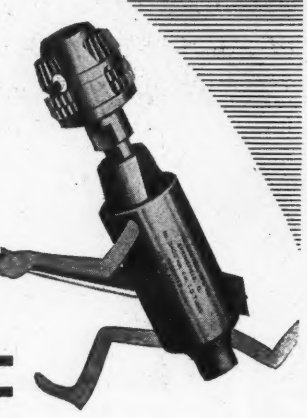
and so...

As our war work is reduced or terminated, this company is prepared — with no change in pace, and without missing a stride — to resume furnishing the highest quality elevators and escalators for all peacetime purposes.

Otis ELEVATOR COMPANY

OFFICES IN ALL PRINCIPAL CITIES

Win your Battle



AGAINST

SCALE

with

AIRETOOL TUBE CLEANERS

Overpower the enemy of power plant efficiency — scale and other deposits in tubes—with powerful, efficient, easier-to-use Airetool Tube Cleaners. This is the tube cleaner with the 28% more powerful motor that can be loaded down to 50 R.P.M. without stalling, with the wide variety of new form cutters that last longer, remove the severest deposits without tracking. No wonder it's easier and quicker to clean tubes with Airetool. Airetool Cleaners are made for tubes ½" to 24" I.D.; Straight or curved.

AIRETOOL TUBE EXPANDERS

Developed to meet the demands for properly rolled joints. Careful construction by expert workmen of finest heat treated alloy steels assures longer life. Made in a wide variety of sizes with universal or right angle drives.

HELPFUL BULLETINS

that tell all about Airetool Tube Cleaners, Expanders and other specialties, their use, selection and care are "yours for the asking." Contains valuable helpful information. Write Dept. PY today.

AIRETOOL MANUFACTURING COMPANY

Airetool & Yost-Superior Factory Bldgs.

SPRINGFIELD, OHIO

FYR-FEEDER

MULTIPLE SPREADER **STOKERS**

BURN COAL LIKE OIL!

Save with Fyr-Feeder—Burn less coal—Cheaper coal—Local coals—Screenings—Coal yard sweepings, wet or dry—Wet coal is no handicap.

FYR-FEEDER

exclusively employs

AIR→ JET ←COAL

PROPULSION

Fines burn in suspension, larger pieces are spread evenly over grates.

Fyr-Feeder increases boiler capacity—responds instantly to sudden load variations—requires no special skill or experience to operate—thin fuel bed eliminates clinkers—makes firemen's work much easier—no banking losses.

CHANGE OVER TO FYR-FEEDER NOW

Easily installed in minimum time.

Fyr-Feeders are built in sizes to burn from 300 to 12000 lbs. of coal per hour. If you are or expect to be in the market for automatic coal burning equipment

Wire or Write

AMERICAN COAL BURNER CO.

22—18 E. Erie St. *Engineers* Chicago 11, Ill.

COAL STRIPPING CONTRACT WANTED

Experienced stripping contractor having, due to exhaustion of present mine, organization and equipment available, desires to produce strip coal and deliver on railroad cars or truck to plant storage pile for utility company or large industrial consumer, thereby insuring it low-cost dependable fuel supply. Will enter into long-term contract and furnish highest references.

Address Box 1468, Power Plant Engineering
53 W. Jackson Blvd., Chicago 2, Ill.

WANTED TO BUY FOR
ST. LUKE'S HOSPITAL, CHICAGO, ILLINOIS

CYLINDER COMPLETE WITH CYLINDER HEAD, PISTON & VALVES FOR
17 × 17 FLEMING 4-VALVE ENGINE
MANUFACTURED BY
HARRISBURG FOUNDRY AND MACHINE COMPANY
Length of Cylinder Casting:
Flange to Flange 32 inches

Please reply to: Vern E. Alden, Engineers
120 South LaSalle Street
Chicago 3, Illinois

DROP-FORGED STEEL
Flanges
The widespread use of Phoenix Drop-Forged Flanges and the consistently increasing demand for them prove conclusively that they meet the most exacting requirements in every respect. They are drop-forged from a mild steel especially suited to welding and machining and are available in a wide range of styles and sizes. They can also be furnished in stainless steel, Everdur brass, and other alloys.
Every Phoenix Flange complies with ASA requirements and ASME and ASTM specifications.
Ask your supplier for Phoenix Drop-Forged Flanges or write direct for our catalog.
Flange Division of
PHOENIX MANUFACTURING COMPANY
CATASAUQUA, PA.
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PHOENIX
Drop Forged
FLANGES
PHOENIX

MIDGET industrial THERMOMETERS

Recommended for equipment requiring SMALL ARMORED THERMOMETERS and where large industrial thermometers are not conveniently applicable.

YEL O BAK thermometers are easy to read, because yellow background apparently gives mercury column a deeper shade.

Write for YEL O BAK Bulletin

Four Sizes

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SCIENTIFIC INSTRUMENTS
POWER PLANT EQUIPMENT

THE REFINERY SUPPLY CO.

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For Safe, Accurate Pressure Control—

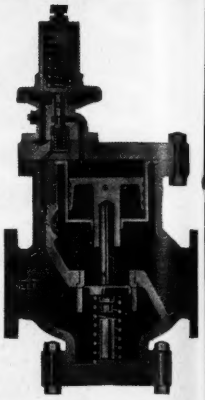
Golden-Anderson

STEAM PRESSURE REDUCING VALVES

★ Will positively hold any adjusted delivery pressure "right on the nose" at all times. Particularly adapted for intermittent or dead end service.

Pilot control may be located remotely from main valve. Efficiently handles 125 lb. to 400 lb. saturated or superheated steam.

This and other specialty valves are described fully in new G-A Catalog. Write today for your copy.



GOLDEN-ANDERSON
VALVE SPECIALTY CO.
FULTON BUILDING, PITTSBURGH, PA.

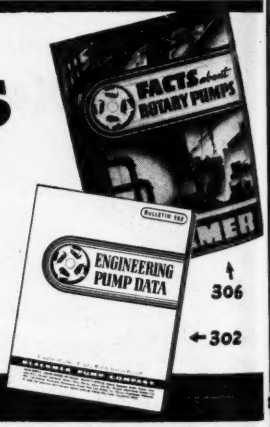
FACTS about ROTARY PUMPS

This bulletin tells you why and how

BLACKMER ROTARIES
are SELF-ADJUSTING FOR WEAR

WRITE NOW FOR
BULLETIN No. 306 — FACTS ABOUT ROTARY PUMPS
Bulletin No. 302 — Pump Engineering Data

BLACKMER PUMP COMPANY
2010 CENTURY AVENUE GRAND RAPIDS 9, MICHIGAN
Serving Industry for More Than 40 Years



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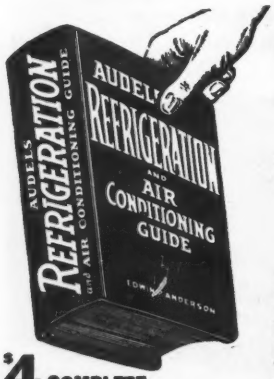
JUST OUT! NEW FROM COVER TO COVER • 1280 PAGES • FULLY ILLUSTRATED



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HOW MUCH DOES A POUND OF STEAM COST YOU?

PLAN NOW FOR POST WAR COMPETITIVE CONDITIONS

THERE'S many an "if" and "but" involved in any plant manager's plans for a safe return to the production of civilian goods. Two things, however, are certain: post-war competition will be severe, and the man who can produce the best quality product at the lowest cost will be the one who will climb to the top in the scramble!

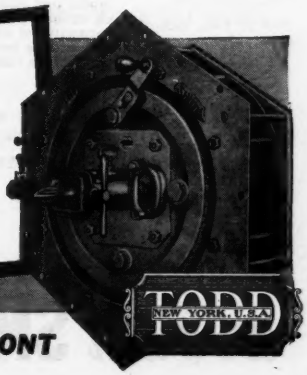
STEAM is an important "raw material" item on any plant's production cost sheet, yet its "price" varies greatly, depending upon the efficiency of the individual boiler plant. *How much does a pound of steam cost you?* In a competitive struggle lower steam costs may well make all the difference between a healthy profit and no profit at all.

TODAY many factories and commercial buildings are already enjoying low-cost steam production with TODD burners. Investigate *your* combustion equipment *now*—compile specifications for improvements that will lower over-all manufacturing costs. Be ready to take advantage of the first opportunity to secure TODD burners. TODD engineers will be glad to make an impartial survey of your boiler plant!

ARMY E NAVY

COMBUSTION EQUIPMENT DIVISION
TODD SHIPYARDS CORPORATION
601 West 26th Street, New York 1, N. Y.

NEW YORK, BROOKLYN, ROCHESTER, HOBOKEN, NEWARK, BARBER, N. J., PHILADELPHIA, SO. PORTLAND, ME., BOSTON, SPRINGFIELD, MASS., BALTIMORE, WASHINGTON, CHICAGO, GRAND RAPIDS, TAMPA, GALVESTON, HOUSTON, MOBILE, NEW ORLEANS, LOS ANGELES, SAN FRANCISCO, SEATTLE, TACOMA, MONTREAL, TORONTO, BUENOS AIRES, LONDON



ON THE FIRING LINE OF AMERICA'S WAR PRODUCTION FRONT

SMOOTH-ON IRON CEMENTS

for hundreds of plant repairs

Sold in 7-oz., 1-lb., 5-lb. cans; 25-lb., 100-lb. kegs.

SMOOTH-ON No. 1
Quick-Hardening

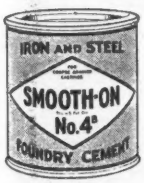
SMOOTH-ON No. 2
Slow-Hardening

For repairing cracks in boilers, heaters, evaporators, condensers, pumps and other castings; stopping leaks at pipe connections, bolts, rivets, seams, etc.; and tightening loose parts of apparatus and fixtures.

Sold in 1-lb., 5-lb. cans; 25-lb. kegs.

SMOOTH-ON No. 3

An Iron Cement for making screw-threaded, flanged, and other thin joints, and coating gaskets.



No. 4AA sold in 1-lb. cans; 10-lb., 50-lb. kegs. Nos. 4A and 4B sold in 1-lb., 5-lb. cans; 25-lb., 100-lb. kegs.

SMOOTH-ON No. 4

For truing up contours of castings and correcting surface blemishes. Selection of four grades to permit matching the color and grain of any iron or steel casting. Also foundry cements for brass, bronze and aluminum castings.

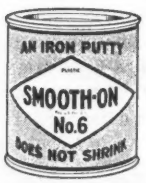
SMOOTH-ON No. 5

An Iron Cement for making caulked bell-and-spigot joints.

Sold in 1-lb., 5-lb. cans; 25-lb., 100-lb. kegs.

SMOOTH-ON No. 6

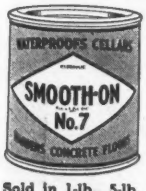
For making watertight joints at roof flashings, glass frames, foundation and window joints, filling in seams and rivet heads.



Sold in 1-lb., 5-lb. cans; 25-lb. kegs.

SMOOTH-ON No. 7

For waterproofing walls and interiors of tanks and cisterns from the inside; for making hard, dustproof and oilproof concrete floors; and for repairing ruts, holes and cracks in concrete floors.



Sold in 1-lb., 5-lb. cans; 25-lb., 100-lb. kegs.

Smooth-On compositions are obtainable from your dealer or, if necessary, from us. For your protection, insist on Smooth-On, used by engineers and mechanics since 1895.

FREE

40-Page Handbook explains how

This useful manual, illustrated with 170 diagrams, gives concise, simple suggestions that will save you time, labor and expense on repair and maintenance jobs all around the plant. A real necessity for every engineer, and will be sent you FREE if you fill in and return the coupon.

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570 Communipaw Ave., Jersey City, N. J.

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Address .....

2-45 .....

Do it with SMOOTH-ON

Use

LESS PAPER

Because:

Paper vests have proved excellent for aviators and ground crews as cold protection.

Paper is used for disposable gun covers and ordnance wraps to protect such equipment while making invasion landings.

The Army supplies helmets of laminated fiber for non-combat duty in the tropics.

Many essential airplane parts are fabricated of plastic with a paper base.

Army trucks require 20 pounds of paper for safe delivery.

It takes 25 tons of blueprint paper to make a battleship.

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FOR SALE

New and Reconditioned Iron and Steel **VALVES**

ALL TYPES AND SIZES
ALSO FITTINGS

Tested and Guaranteed

APEX IRON & METAL CO.
2204 S. Laflin St. **Chicago 8, Ill.**

WICKES

Horizontal Cross Drum Boilers
Vertical Water Tube Boilers
Inclined Curved Tube Boiler
Horizontal Tubular Boilers

BOILERS

The WICKES BOILER CO.

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SAGINAW, MICH.

7 ways to use LUMNITE in power plants

Operators and builders of steam power plants reduce outages and maintenance costs by using corrosion-resistant and heat-resistant concretes and mortars made with this special cement.

1. **Ash Pit and Cinder Catcher Linings**—Heat-Resistant LUMNITE concrete withstands wear and corrosion in both wet-type and dry-type units.
2. **Coal Bunker Linings**—LUMNITE concrete resists abrasion and corrosion.
3. **Flue and Duct Linings**—LUMNITE concrete resists abrasion of flue gases and fly ash, provides insulation where required.
4. **For Steel Stacks**—Jointless LUMNITE linings, generally applied with a cement gun, protect steel stacks from corrosion; their insulating properties improve efficiency.
5. **For Brick Chimneys and Linings**—LUMNITE mortar resists attack of sulphur compounds from stack gases; especially good when operating intermittently or at low temperatures.
6. **Castable Refractories, made with LUMNITE**—used for jointless walls and arches, baffles, burner blocks, door linings, stoker settings and general refractory purposes.
7. **Overnight Structural Concrete**—For rapid maintenance, LUMNITE provides full-strength concrete in 24 hours or less, even in freezing weather.

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WHAT IS LUMNITE?

LUMNITE is a special hydraulic cement for special purposes. It is of the calcium-aluminate type and is not a portland cement. It is essentially a structural cement used with special aggregates to make concrete having corrosion-resistant and heat-resistant properties, and for rapid-hardening structural concrete.

LUMNITE is packed in multi-wall, moisture-proof paper bags and may be stocked like portland cement. For convenient volume measurement, one cubic foot of LUMNITE is packed in each bag.

LUMNITE AVAILABLE NOW

LUMNITE can now be purchased without restrictions or priorities. It may be obtained from building supply dealers throughout the United States and in Canada.

Send for the names of dealers near you and for detailed information on specific uses of LUMNITE in power plants. Also ask for reprint of article **"Deterioration and Maintenance of Power Plant Structures."**

THE ATLAS LUMNITE CEMENT COMPANY

(United States Steel Corporation Subsidiary)

135 East 42nd Street • New York 17, N.Y.

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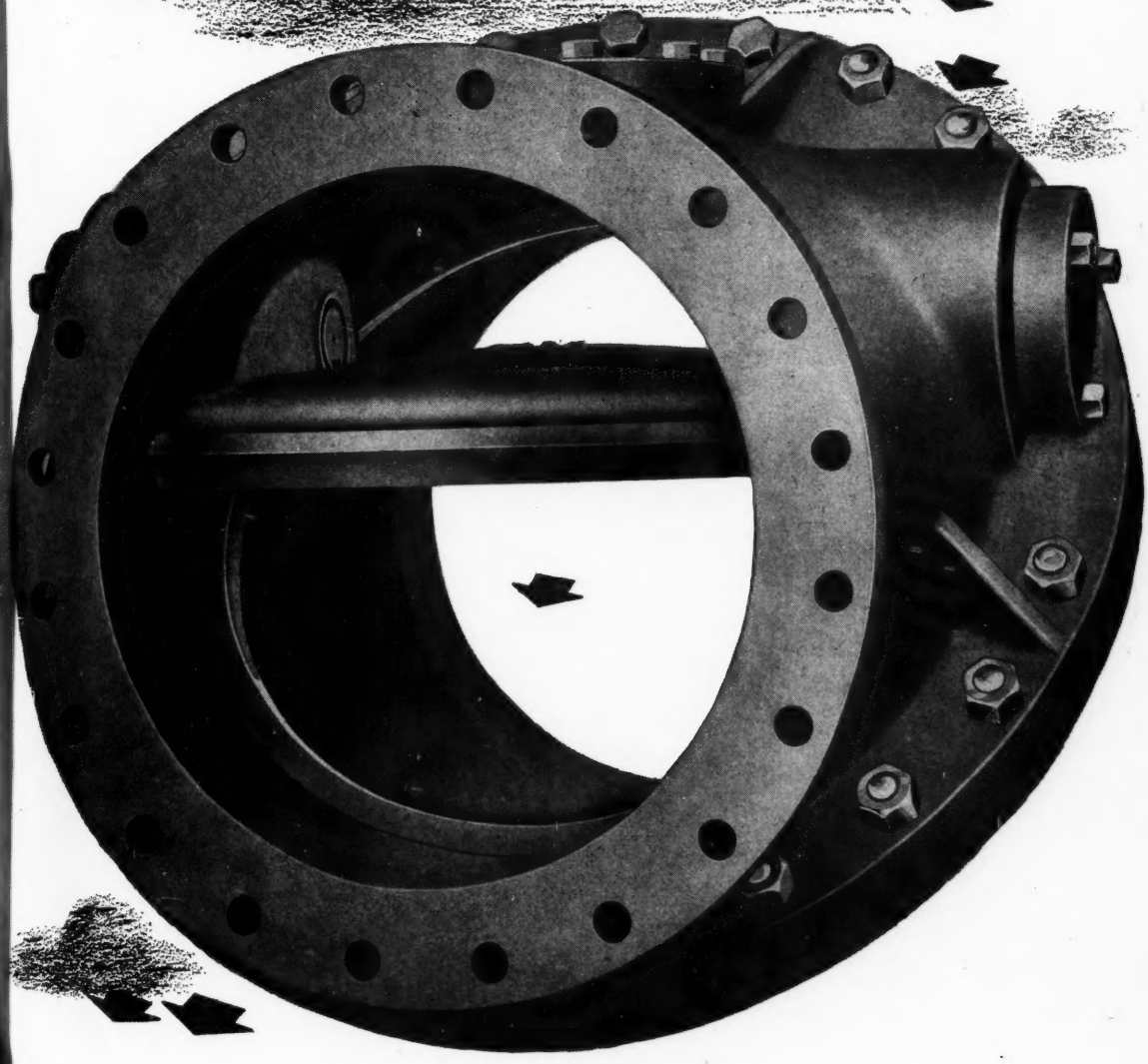

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